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Minerva Promachos
Approaches to the Acropolis as seen from the Pnyx
 (102, Temp. Aug. Imp.)
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AN INVESTIGATION
OF
THE PRINCIPLES
OF
ATHENIAN ARCHITECTURE

OR
THE RESULTS OF A SURVEY CONDUCTED CHIEFLY WITH REFERENCE TO THE
OPTICAL REFINEMENTS EXHIBITED IN THE CONSTRUCTION OF
THE ANCIENT BUILDINGS AT ATHENS

BY
FRANCIS CRANMER PENROSE, ARCHT., M.A., F.R.A.S.

HONORARY FELLOW OF MAGDALENE COLLEGE, CAMBRIDGE
MEMBER OF THE SOCIETY OF DILETTANTI

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κατ' ἀλήθειαν ἰσότητος ἢ εὐρυθμίας ἀλλὰ τῆς πρὸς τὴν ὄψιν στοχαζομένης.

HELIODORI LARISSÆI CAPITA OPTICORUM

NEW AND ENLARGED EDITION

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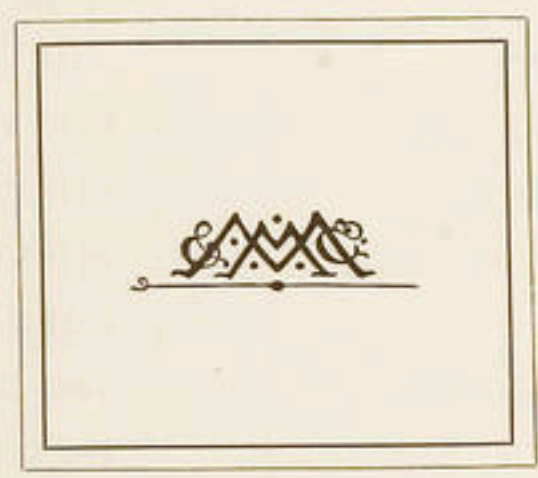
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THE AUTHOR'S PREFACE

TO THE FIRST EDITION

THE work which is offered to the public in the following pages is not intended to supersede any which have gone before it or to be itself considered a complete treatise on Greek art. It professes simply to be a faithful record of observations made on the spot, and much of it is illustrated by citations from the best authorities.

On visiting Athens in the year 1845 I found that although the architectural remains in that city had received a great and well deserved share of attention, both from their earliest and best delineator, Stuart, and also from those who have followed in his steps; yet as they had entirely overlooked several subordinate, but far from unimportant features, which have been observed by later travellers during a period of nearly one hundred years, and especially as some of the most highly interesting particulars of this nature had only very recently been brought to light, it seemed very desirable that this deficiency should be filled up by an exact delineation of some of the principal buildings of the best time.

On my second visit to Athens in the autumn of 1846 I immediately renewed my observations in and about the Acropolis; and continued them till the following May. The Parthenon was selected as the object of the most particular attention, and all the points in that building which showed any departure from ordinary forms were afterwards carefully compared with corresponding features in the Propylæa, the Theseum, and some other temples. The work now brought forward may be described as a treatise on the systematic deviations from ordinary rectilineal construction, found in the principal works of Greek architecture, which arise out of and pervade the entire design of the building. The aim proposed is, first, the establishment of the fact of those deviations; secondly, the determination of their exact nature and forms; and lastly, the bringing forward some views as to the theory on which they were founded. My object generally has been to fill up what had been left imperfect by Stuart and Revett, and if this work shall be accepted as supplemental to their labours, its end will be fully answered. In the case of the Propylæa the beautiful drawings from which the plates have been engraved were prepared by my friend and companion at Athens, Mr. T. I. Willson. The plan of the work will be readily understood from the Table of Contents; and as in the course of the text I have had frequent occasion to speak of mathematical principles, I have added in the Appendix a summary of those properties of the Conic Sections, and some other curves, which require to be borne in mind: and it is hoped that these short notices will enable my readers to follow the immediate subject without difficulty. A glossary of mathematical and technical terms has been added with a similar view. The Appendix also contains several other matters which, whilst they would have encumbered the text and notes, yet could not be omitted altogether.

The Frontispiece is supposed to represent the appearance of Athens in the time of the

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Emperor Augustus. In the Acropolis nothing is introduced which is not warranted by strong evidence. In the adjuncts a little more liberty has been assumed. For instance, with the exception of the steps which remain, the restoration of the Areopagus is imaginary; also there is no positive authority for the external appearance of the Dionysiac Theatre and the Doric Portico represented near it. Otherwise, none but very subordinate objects have been introduced conjecturally. It is presumed that at the time to which the view refers the population of Athens had so much declined that the west and south-west sides of the Acropolis had been already deserted for the northern and eastern, where there is a better supply of water. This theory will not indeed account for the omission of the Temple of Æsculapius and some other public buildings, but in almost all cases where the sites can be only approximately determined, and the forms are unknown, the natural features of the ground have been introduced as more characteristic. The Temple of Jupiter Olympius was in progress at the time of which we are speaking, but its degree of completion is uncertain.

In the Acropolis all the principal objects represented are still remaining in a greater or less state of preservation. Of the colossal statue of Minerva Promachus indeed only the base of the pedestal remains, but there are numerous allusions to its height and features by ancient writers, and some very rough representations on coins. We are told by Pliny that the chryselephantine figure in the Parthenon was 26 cubits, or 38 English feet, in height, and we know that the bronze colossus, of which we are speaking, was the larger of the two. I have supposed the latter to be 45 feet high, and this, as it seems to me, is the minimum height consistent with these authorities. The rapid rise of the ground at the first entrance to the Acropolis, and the great height which it was the general practice of the Greeks to give to the pedestals of their statues, account for its towering appearance above the roof of the Propylæa. It should be mentioned that although in the plate it is drawn with the ægis only, it is more probable that the statue also carried a shield.

Doubtless many other statues and works of art would have been visible in such a view of the Acropolis; and it is most likely that the south wall was enriched with one or more rows of sculpture along its summit, representing the Titano-machia, and the combat of Attalus and the Gauls. In the view it is supposed that a pedestal under the north wing of the Propylæa which, it may be gathered from a hint given by Pausanias, was intended to support a group representing the sons of Xenophon, had not yet given place to the later, and, as I have supposed, larger pedestal now existing, and which bears an inscription to Agrippa.

There is some uncertainty respecting the line of roadway in the middle of the lower division of the steps leading to the Propylæa. I have endeavoured to combine a zigzag approach, which is required by the steepness of the ascent, with the steps, indications of which still remain on the side walls. Considerable fragments of the upper part of the roadway between the columns remain, formed of slabs of marble. These are shown more at large in Plate XXVIII. and those which follow. With respect to the front wall of the fortification and the approaches, the reader is referred to what is said on this subject in Chap. I., and in Chap. X. Sect. I. The battlements are copied from those at Messene and the fortress of Ænoë near Eleutheræ.

The measurements of the columns and entablature, and the representations of the capitals of the Temple of Jupiter Olympius (see Chap. XII. Plates XXXVII. XXXVIII. XXXIX.), are now for the first time accurately given.

The author takes this opportunity to thank those friends who have kindly assisted him in the progress of this work. Mr. Willson, whose name has been already mentioned, has not only contributed the drawings illustrative of the Propylæa, from which Plates XXIV. to XXXII. inclusive have been engraved, but has rendered valuable assistance in many other respects.

A particular acknowledgment is also due to the kindness of Mr. G. Finlay of Athens, with whom the author has been in frequent communication, and to whose co-operation in verifying such results as required confirmation, both personally, and also with the kind assistance of Mr. Edward Riedel, a Bavarian architect, until lately resident at Athens, the work has been greatly indebted. Professor Cockerell, R.A., has also placed at my disposal his valuable collection of

Athenian sketches and measurements. To Mr. Carter also and the other engravers, lithographers, and printers, my thanks are due, for the pains they have taken in their several departments.

But my chief and paramount obligations are due to the Society of Dilettanti, who encouraged me to make my second visit to Athens, who obtained for me the facilities which were required for carrying on my operations there, and without whose liberality in undertaking the publication of this work, no part of it would in all probability have been given to the public, certainly not to the extent or with the advantages it now possesses.

F. C. PENROSE.

PREFACE TO THE SECOND EDITION

AS early as the year 1883 the Society of Dilettanti determined to publish a second edition of this work, and, with a view to carrying out this intention, I undertook to re-examine the buildings of which mention was made, so that the discoveries of recent years might be incorporated in the book, and particularly in the case of the Erechtheum, which had been very slightly touched upon in the first edition; and with respect to the temple of Jupiter Olympius, I was desired to obtain, if possible, permission to make excavations for the purpose of ascertaining the plan of the internal walls. With these objects in view I resided at Athens for about six weeks in the autumn of that year, and obtained much of the necessary information; and my subsequent connection with the British Archæological School, first as Honorary Architect and afterwards as Resident Director, gave me further opportunities both of completing what had been insufficiently examined in 1883 and also of bringing down the results of new discoveries on the Acropolis, so far as they bear on the subject of this work, to a very recent date. Much new matter has been added to the description of the Propylæa and the parts adjacent to it. The plan of the temple of Jupiter Olympius has been recovered in all essential particulars, of which an account will be given in Chapter XII., and there is an entirely new chapter on the Erechtheum. A description of some very interesting particulars respecting the earlier Parthenon will be found in Chapter XIV. I have no occasion in this edition to repeat the observations I formerly made on the proportions of the different buildings of which mention is made—that subject having been completely solved by Mr. W. W. Lloyd; and I am enabled to insert, by permission, an Essay contributed by him to the Royal Institute of British Architects, on the scheme of proportions employed by the Greek architects, especially illustrated in the case of the Parthenon, which forms Article 1 of the Appendix. Seven new copper Plates and about twenty woodcuts have been added to the book. A few errors which were found in the first edition have been corrected; the principal one of these was in the Plate showing the remains of the earlier Parthenon. On the section the word eastern should have been used instead of western; previous to this correction it was made to appear that the shorter architrave stones had belonged to the front of that temple. In consequence of the large amount of new matter introduced, it has been thought desirable to omit from this edition the glossary of mathematical and technical terms.

F. C. P.

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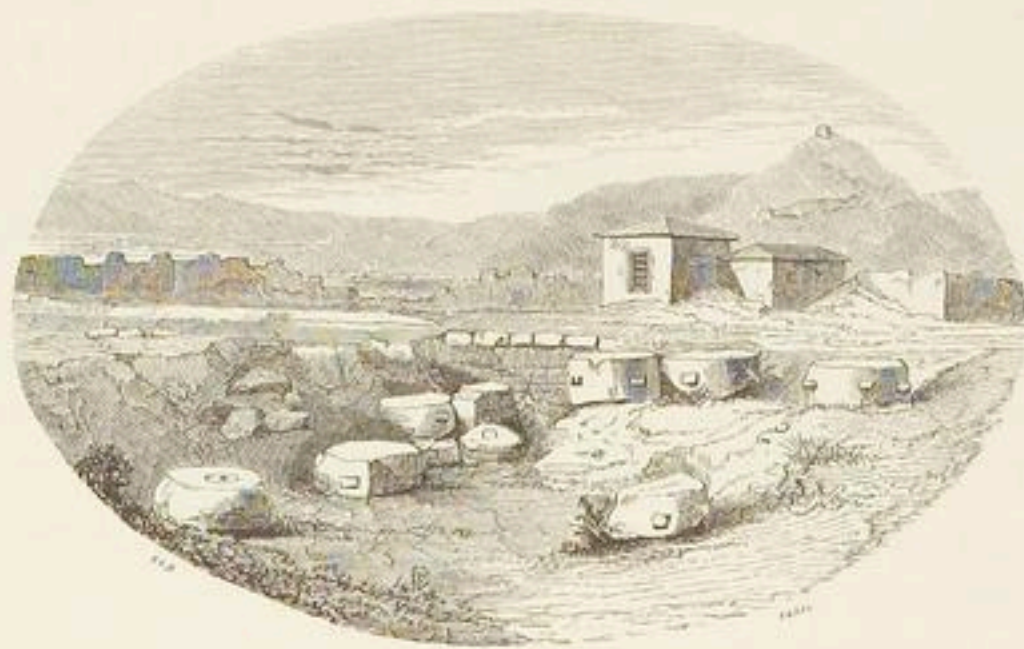
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CHAPTER I

GENERAL DESCRIPTION OF THE ACROPOLIS OF ATHENS

SECTION I

PLAN OF THE ACROPOLIS. PLATE II.

THE different conventional signs used on this plate are explained on the margin of the plate itself. The darker tint denotes Hellenic or ancient work; the lighter, mediæval or modern; the general slight tint, such parts as in 1846 had been laid open by excavations. As much interesting matter is to be gathered from the fragments of more ancient structures which have been at various times built into the wall of the Acropolis, these will require a few preliminary observations.

On the ascent on the north side to the Acropolis from the modern town our first attention is called to the angle of the Hellenic wall, west of the Pinacotheca or northern wing of the Propylæa, namely the internal angle nearest to the large pedestal which bears an inscription to Agrippa. (See Leake's *Athens and Demi of Attica*, 2d ed. pp. 327-331.)

It is probable that this wall formed the exterior defence of the Acropolis at this point; it is not now traceable farther south than is shown by the dark tint, the continuation being of more recent construction. The walls west of this line exhibit some peculiarities of structure, but being all mediæval, are not within the scope of this work. Following the first-mentioned wall, northwards, we soon come to a bastion, built about the year 1824 by the Greek General Odysseus to defend an ancient well, to which there is access within the bastion by an antique passage and stair of some length cut in the rock. The ancient wall referred to above was rebuilt in 1885.

Turning eastwards round the corner, we come to two shallow caves, one of which is supposed to have been dedicated to Pan; in these caves are traces of tablets which were let into the rock.

Beyond the large buttress (so named on the plan) the wall is built upon the edge of the nearly vertical rock. On passing round a salient angle, where is a small buttress, we find a nearly straight line of wall for about 210 feet; then a short bend to the south-east; afterwards a farther straight reach for about 120 feet, nearly parallel to the former. These two lines of wall contain very interesting remains of Doric columns, entablature, and steps of large size; which will engage our attention hereafter (Chap. XIV.) A mediæval buttress about 100 feet to the east of the Erechtheum, forms the termination of this second reach of wall; from hence to the north-east angle of the Acropolis, where on the plan is marked a tower apparently Turkish, occur several large squared stones, which also appear to have belonged to some early temple.

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The wall, into which these as well as the before-mentioned fragments are built, seems to be of Hellenic construction. From the angle nearest the Erechtheum, to the last-mentioned tower, the natural rock, although still very steep, is less inaccessible than almost anywhere else except at the Propylæa; here also the wall immediately surmounts the cliff.

The eastern face of the wall, which appears to have been entirely rebuilt in the middle ages on the old foundations, is almost undermined, about the middle of its length, by a large cave in the rock. Here is a ledge of several feet in width between the summit of the precipice and the base of the wall. Other examples of such ledges occur in ancient fortresses. In one part of the fortifications of the Piræus a space of about 40 feet intervenes between the bottom of the wall and a broad foss in front of it, which perhaps was intended to provide more effectually against the *helepolis* and other battering engines, than if the wall were built immediately on the edge of the ditch, as in that case it might have been battered by engines brought up to the edge of the foss. However, in the case of the Acropolis wall, a regular attack by engines could not have been apprehended, as no other check seems to have been provided against an enemy taking advantage of the above-mentioned ledge than the small projecting tower at the north-east angle, which, owing to the nature of the ground, was probably an ample provision; but the method of fortification by means of flanking towers was not unknown to the Greeks. At the fortress of Cœnoë, near Eleutheræ, on the borders of Bœotia, the square towers which project in front of the wall on the north side of the castle have their outer faces not parallel to the curtain, but in a line with the internal angle of one of the adjacent towers.¹

At the south-east angle, we again find the Hellenic masonry of the south wall (or Cimonium) built by Cimon the son of Miltiades. At this point twenty-nine courses remain, making a height of 45 feet. This, instead of being quite perpendicular, batters, or sets back, about 2 feet in the whole height, each course being placed a little within the one below it, so as to leave a narrow horizontal ledge at each joint.

As we follow the wall westwards, we find that it has been almost entirely cased in mediæval and recent times, and is further supported by nine buttresses; these, as well as those on the north and east sides, appear to be mediæval. It is not unlikely that valuable remains might be found embedded among the stones which form this casing. A few fragments of sculpture are visible, among which may be mentioned a portion of drapery nearly under the west front of the Parthenon not unworthy of the time of Phidias.

The Hellenic masonry of the Cimonium can be traced all along, as far as the Propylæa, under the casing; where the latter has been shattered.

A little to the west of the Dionysiac Theatre occurs a deep course of limestone, called *poros*, from the quarries of the Piræus, probably a fragment of some early temple; see Plate XLVI. and Chap. XIV.

A little farther on, this wall is in one place 65 feet high, and the casing batters 7 feet. That part of the cliff, which appears at the foot of the wall and below it, is not so steep as on the north and east sides, and nowhere is it quite inaccessible; but it is probable that the parts of the cliff hidden by the wall are more precipitous, and until the time of Cimon were considered to be sufficiently defended by nature, or by the original Pelasgic walls.

The south-west reach of the Hellenic wall terminates westwards in a solid tower about 30 feet high, which is surmounted by the temple of Nike Apteros, of which the greater part has recently been discovered, and restored on the original site. These defences commanded the unshielded side of any troops approaching the gate, which there is good reason to believe,² was in the same position as the present entrance. After passing through the gate and proceeding northwards underneath the west face of the tower, we come to the Propylæa; a building which in its ruined state is still so impressive, that we may well believe that it was the wonder and admiration of all antiquity. The effect of emerging from the dark gate, and narrow passage, to the magnificent marble staircase 70 Greek feet broad, surmounted by the Propylæa decorated throughout with the sculptures and paintings which adorned this building when perfect, may well have called forth the pride of Athenians and the envy of the rest of Greece.³

¹ This contrivance is precisely the same in principle as the modern method of fortification introduced by Sanmichele, who must have had frequent opportunities of visiting the 'παλαῖον κούρην' of Greece.

² See Chap. X. Description of Plate XXVII.

³ προπύλαια ταῦτα, etc. *Æschinis παραπρόσθετα*, p. 279, Reiske.

The Propylæa and parts connected with it are described in Chap. X. under the head of Plate XXVII.

The road leading upwards after passing the Propylæa is slightly worked out of the rock; it is at first of considerable breadth, and afterwards becomes narrower. Close to the Propylæa, where the road is steep, it exhibits remains of cross grooves or channels cut at right angles to its course, for the purpose of giving a better foothold.

The colossal statue of Minerva Promachus was here seen a little to the left; and the Parthenon to the right; both offering angular views, according to the usual custom of the Greeks in arranging the approaches to their temples and public buildings.¹

Immediately on the right hand as we leave the Propylæa, and on the road itself, are traces of votive altars, one of which is dedicated to Minerva Hygieia.² We then find some steps cut in the rock leading to a somewhat higher level, figured (24) on the plan;³ next occur several small troughs, about one foot long, sunk in the rock, perhaps intended to serve as attachments to monuments or works of art. These lie in the line of a levelled terrace smoothly cut out of the rock, and pointing exactly to the site of the statue of Minerva Promachus.⁴

If we now cross the road we find a levelled area slightly oblique to the lines of the pedestal of the great statue, and proceeding farther northwards come to a staircase close to the edge of the rock, partly built, partly cut out. This staircase passes downwards through a deep cleft in the rock, nearly parallel in its direction to the outer wall, and opening out in the face of the cliff a little below its foundation. In the year 1845 it was possible, by rather difficult climbing, to creep into this passage, and ascend into the Acropolis; but since that time the entrance has been closed up. Another staircase, discovered in 1886, will be mentioned in Section II. of this Chapter.

Returning to the road between the Propylæa and the Parthenon, a little above the spot marked (20), we rise to a spacious, smoothly levelled area figured (17), having its bounding lines nearly parallel to those of the Parthenon, and communicating by steps, partly cut in the rock, with the platform which supported the pavement immediately below the west front of the temple. This area has been entirely cleared of rubbish. The vertical faces which had been formed in the rock are honeycombed with the insertions for votive tablets probably of rather late date.

Following the platform southwards, the rock disappears, and its place is supplied by a pavement of stone, of which considerable portions remain. A solid wall of blocks of Piræic stone but not Hellenic construction separates the last-mentioned area from the upper level, marked (11). The rock does not crop out anywhere to the south of the Parthenon. Close to the temple the original soil (that is, the surface as it would have appeared at the time the Parthenon was built), was formed of made ground in three layers of chips of stone; the lowest being of the rock of the Acropolis, the next of Pentelic marble, and the uppermost of Piræic stone, all which are easily distinguished from the unconformable deposits of mediæval dirt, shells, and pottery above them. One of the most remarkable parts of this extensive excavation occurs immediately to the east of the Parthenon, figured (15), where remain a number of drums of columns, formed of Pentelic marble, in a more or less perfect state, some much shattered, others apparently rough from the quarry, others partly worked, and discarded in consequence of some defect in the material. The ground about them was strewn with marble chips; and some sculptors' tools, and jars containing red colour, were found with them.⁵

To the south of this portion of the excavation, and upon the edge of the Cimonium, is a platform of Piræic stone, evidently the broad summit of the wall, which contains two plain marble slabs, perhaps connected with the sculptures relating to the story of Attalus and the Gauls (see Leake, *ibid.* p. 349). A small portion of a similar platform is discovered close to the eastern wall of the Acropolis.

Beyond the drums of columns, due east of the south-east angle of the Parthenon, is a small excavation, where a fragment of a wall built of Piræic stone has been laid open. See Section II. of this Chapter.

¹ Leake's *Athens*, page 516.

² See Plate XXI, Fig. 35, and Leake's *Athens*, p. 145.

³ The numbers in parenthesis denote the approximate levels of the points indicated, measured downwards from the north-west angle of the upper step of the Parthenon. This site was probably that of the Temple of Diana Brauronia.

⁴ It may have been not without meaning that the side of the base of

this statue made an angle of $\frac{3}{4}$ of a right angle with the axis of the Erechtheum, and an angle of $\frac{1}{2}$ a right angle with the direction of the above-mentioned terrace.

⁵ Vide a letter written by Mr. Bracebridge, dated 1837, in the library of the Institute of British Architects. See also the vignette at the head of this chapter in which this excavation is represented.

Returning to the Parthenon, we find in front of the eastern portico considerable remains of a level platform, figured (6), partly of smoothed rock, and partly of blocks of Piraic stone. Lying on this pavement are some fragments of the materials of a circular building of later architecture, apparently Corinthian, and probably the Temple of Augustus and Rome. Except that it was centrally east of the Parthenon there seems no evidence to show its exact site. The platform is bounded on the north by a low vertical face cut in the rock, which points exactly to the site of the statue of Minerva Promachus. Here is the highest part of the Acropolis rock, figured (3). Perhaps this and some other places, where the rock is not smoothed, may have been occupied by domestic buildings.¹

Westwards of this spot we arrive at the area between the Parthenon and Erechtheum, which slopes from the former to the latter. Near the Parthenon are two small wells or rather cisterns excavated in the rock, which may have been supplied with water from the roof of the temple.

Close to the south, or Caryatid portico of the Erechtheum, a small levelled platform (15) was visible in 1846, which has been discovered to have formed part of the foundation of a large temple.²

Towards the north-east of the Erechtheum, the communication between the different levels of its eastern and northern porticoes must have been effected by a flight of steps, which have now disappeared.³ There seem to be no distinct traces of any to the south-west, where there is an ancient retaining wall of rather rough Piraic stone-work in a direction nearly east and west.⁴

Returning southwards along the line of the west front of the Parthenon produced, we encounter a marble slab apparently *in situ*.

Before leaving the Erechtheum we may observe that the remains of a Turkish powder magazine which encumbered the northern portico of this temple were removed in 1846, and the columns appear as in the vignette at the end of Chapter XIII.

Before quitting the general plan of the Acropolis, it will be well to observe the remarkable absence of parallelism among the several buildings. Except the Propylæa and Parthenon, which were perhaps intended to bear a definite relation to one another, no two are parallel. This *asymmetria* is productive of very great beauty; for it not only obviates the dry uniformity of too many parallel lines, but also produces exquisite varieties of light and shade. One of the most happy instances of this latter effect is in the temple of Nike Apteros in front of the southern wing of the Propylæa. The façade of this temple and the pedestal of Agrippa, which is opposite to it, remain in shade for a considerable time after the front of the Propylæa has been lighted up; and they gradually receive every variety of light, until the sun is sufficiently on the decline to shine nearly equally on all the western faces of the entire group.

A similar want of parallelism in the separate parts, is found to obtain in some of the finest mediæval structures, and may conduce in some degree to the beauty of the magnificent Piazza of St. Marc at Venice.

SECTION II

MORE RECENT DISCOVERIES ON THE ACROPOLIS

THE most important results of the more recent researches on the Acropolis are found in the neighbourhood of the Erechtheum. In the first place may be mentioned the solid foundations in Piraic, or, as now more generally called, *poros* stone, shown on the plan to the north-west of the temple, which abut upon the north wall of the citadel. A little to the south of these are some slight and roughly-constructed walls of small stones built without mortar but compacted with earth, which probably belonged to domestic buildings of a poor and mean character, some of which may have been as old as the Persian invasion. There are near these some foundations of a wall oblique to the Erechtheum which will be described in

¹ An examination of the sites of ancient dwellings on the rocks of the Areopagus, Nymphæum, and other hills of Athens, shows that often a very small part only of the areas, which appear to have been under cover, was cut smooth, the greater part of the surface being left in the natural state. The floors may have been of plaster, upon a level of dry, or concreted suggestum.

² The late Mr. James Fergusson in his *Discussion of the Erechtheum*,

published by the Institute of British Architects in 1876, identified this platform with the Cecropium. See Section II. of this chapter.

³ See Plate XLV., where a plan of these steps is shown as derived from the insertions of the steps into the north wall of the Erechtheum.

⁴ In Section II. this wall is shown to be part of the sub-basement of the temple just referred to.

Chapter XIII. Close to the masonry above mentioned, and a little to the east of them, and particularly in the neighbourhood of the point marked A, were found in the beginning of 1886, some very remarkable archaic female statues, resembling in great measure the Æginetan sculptures, but apparently of a rather earlier date. They seemed to have suffered, in the first instance, from intentional violence, but had been afterwards laid down where they were found, and some of them were covered with slabs of stone. There could be little doubt that these sculptures had belonged to temples destroyed or defaced by the Persians, and when the buildings were afterwards restored the sculptures were considered as obsolete and no longer suitable for the more perfect structures which were being constructed. They were, however, still treated with some degree of reverence, and put out of sight in the manner described, the Minerva Polias—τὸ ἀρχαῖον ἄγαλμα—having probably alone been retained on account of its peculiar sanctity. Some of the sculptures referred to were found in a small chamber built in the same rude manner as the domestic walls above-mentioned. The sculptures themselves, except where they had been purposely mutilated, were wonderfully fresh, and retained evidence of the painting and toning which had been applied to them—*circumlitio*. They are not all of the same date, and, excepting two or three, are smaller than life size. Some were more fully coloured than others, the flesh was in no case painted, but it seemed to have been toned, without at all concealing the quality of the marble. The colours were chiefly found on the borders of the drapery and on part of the hair. It is evident that even at this early date the colour was applied with much reserve. Several additional archaic sculptures, both marble and bronze, have been found to the north-east of the Erechtheum.

The most interesting addition to our previous knowledge of an architectural character, is that of the site and the general plan of a large ancient temple which formerly stood between the Erechtheum and the Parthenon, but close to the former. Mr. Fergusson, and afterwards Michaelis, had already assigned this position to the Cecropium, but the complete discovery of the outline and general plan of the temple is due to Dr. Dörpfeld, who has also pointed out a number of fragments as belonging to it, as well as passages in ancient authors which appear to him to have reference to it. The rough wall which is shown on Plates II. and XLI. as passing under the caryatid portico, and making a slight angle ($4^{\circ} 14'$) with the axis of the Erechtheum, formed part of the sub-basement of this temple, and its westerly return, although in a more ruinous state, may also be traced, and its south-eastern angle is clearly to be made out cut in the rock. One piece of the stylobate near the caryatid portico is still in position and measures 5.10 feet in breadth on the upper surface. Other blocks of the stylobate have been identified, dispersed in various places. The portion of stylobate mentioned above, and a fragment of a large Ionic capital recently found closely contiguous to the eastern end of this site, appear to give the proper clue to the restoration of the peristyle of this temple; namely, that it was of the Ionic order; which is the more probable, since, as Leake observes,¹ this was in early times the national order in Attica, an opinion further strengthened by the style of the Erechtheum, which was the immediate successor of the temple I have called the Cecropium. The fragment referred to admits of an exact restoration of the volute and of the distance from the face of one volute to that of the other measured on the return, that is, perpendicular to the frontage: this dimension is 3.67 feet. The diameter of the column, however, has to be derived from the analogy of other examples. Several small Ionic capitals of archaic type which have been found on the Acropolis enable this to be recovered, without much room for error, as 3.50 for the upper and 4.0 for the lower diameter, and if a base similar to that of the early temple of Juno at Samos be added, the total diameter as the column stood upon its stylobate would be about 4.60. The breadth of the stylobate as already mentioned was 5.10, so the agreement between these two parts is as exact as could be desired.

The length and breadth of the stylobate as shown in Plate XXXIV. are 141.56 and 69.99 respectively. These dimensions, reduced to the centres of the columns, become 136.46 and 64.89. With a column of the diameter mentioned above, octastyle is the only possible arrangement suitable for the front, and this requires sixteen columns for the flank. The columniations being 9.270 and 9.097 respectively, giving a small and suitable excess to the front intercolumniations. The position of the portion of the stylobate *in situ* also helps to confirm this view. From the north-west angle of the stylobate to the centre of this stone (shown in plan and section in Plate XXXIV., and in plan

¹ *Topography of Athens*, p. 513.

in Plate XLI.) the distance is 52.53. From the centre of the angle column this is reduced to 49.98. But five and a half flank columniations give 50.035, showing that the stone would be accurately central between two columns, and the sinking which is found upon it, apparently for the fixing of some statue, would be symmetrically placed. Dr. Dörpfeld has, indeed, restored this temple in a very different manner,¹ with six columns in front and twelve on the flank, and has claimed for it the large poros stone entablatures and the large capitals which will be described afterwards; but there seems stronger evidence to show (see Chapter XIV.) that they are more legitimately due to the earlier Parthenon. In Dr. Dörpfeld's works here cited the plan of the existing remains is beautifully and carefully given, and to this the reader is referred, as well as for the arrangements of the cella, which are very peculiar; all that has been attempted here is the disposition of the columns of the peristyle, and it may be asked where, if not here, can a place be found for the large Ionic column of which the capital has been described.

The platform, visible in 1846, and which has been already mentioned in page 4, evidently formed part of the foundation of the cella wall. The Temple was probably the most ancient temple of Minerva on the Acropolis, and we can hardly be in danger of error in also applying to it the name of Cecropium, as pointed out by what appears to be the allusion to it in the Erechtheum inscription:—

τὸν τοῖχον τὸν πρὸς νότον
ἀνέμου ἀκατάχεστον
πλὴν τοῦ ἐν τῇ προστάσει
τῇ πρὸς τῷ Κεκροπίῳ.

Probably no temple bearing the name of Cecropium was standing at the time the inscription was written, but the name would have been preserved, and with, most likely, an altar erected on the old site.

The capital shown on the right-hand part of the woodcut, is drawn from a cymagraphic tracing of a well-preserved fragment of poros stone, taken from an excavation at the south-east angle of the Parthenon (carried at least 37 feet below the upper step without exposing the rock, and from which many interesting archaic fragments were recovered). It is identical with the capital, engraved in Plate XXXIV., which is embedded in the Cimonium wall—generally well preserved, but with its echinus mutilated. The curve was accurately parabolic. Five or six fluted drums of columns of the same material, and coated with fine stucco, and which agree well with the capital above described, have also been found. These remains determine the upper diameter of the column, and establish the fact that it had an entasis, but are not sufficiently numerous to give the exact figure nor the accurate measure of the lower diameter—still 18 or 19 feet for the height must be a fair approximation, and 4.10 or 4.20 feet for the lower diameter. One of these columns is engraved in Plate XXXIV. in connection with the plan of the Cecropium, having been drawn on the hypothesis that they had been used for the peristyle of that temple; but subsequent researches make it much more likely, as already stated, that the order was Ionic; and it will be shown in Appendix, Art. 2, that the Doric columns were probably those of the Naos of the earlier Parthenon.

The larger capital shown in the woodcut is one of two specimens closely resembling each other, which are built into the north wall of the Acropolis.² The upper diameter of the column, as established by this specimen, is 4.280 feet, that of its fellow 4.096. These capitals, both from their size and material (poros stone) may be fitly associated with the entablatures already mentioned and engraved on Plate XLVI. From the analogy of the temple at Corinth³ it may be inferred that the columns with the larger diameter supported the front architraves, 13.268 feet long, and the smaller the flank architraves, 12.561. The curve of the echinus is hyperbolic.

To the north-east of the Erechtheum are some remains of ancient walls, some of which may have belonged to the Temenos of the Cecropium, before the Erechtheum, as we now see it, was rebuilt.

¹ *Mittheilungen (Athenische Abtheilung)*, XI. 337; also *Antike Denkmäler*, folio, Berlin 1887, band I.

² The excavation referred to, made along the inside of the wall, has displayed many interesting fragments, it also shows that whilst the upper courses of the wall are very carefully finished, the lower courses, which contain the marble drums mentioned in page 1, are of exceedingly rough

construction, as if built in a hurry. Since the above was written four other capitals of similar character, but belonging to columns of rather smaller diameter, have been discovered. The particulars of these will be given in Chapter XIV.

³ At Corinth, front columniation 13.19, lower diameter 5.64. Flank columniation 12.14, lower diameter 5.35.

Here also, as shown on Plate II., was an ancient access, by means of rough steps, to the citadel, which seems to have been blocked up in comparatively early times. This stair, taken in connection with the walls discovered in the vicinity, renders it probable that we have here the palace of the ancient kings analogous to those at Tiryns and Mycenæ. Returning to the north-west of the Erechtheum, we find, near the projecting angle of the citadel, the original staircase very recently brought to light, which led to the grotto of Aglauros. The other staircase near it, namely that mentioned by Colonel Leake, is evidently of more recent construction. Northwards of the Propylæa are some massive substructions which seem to be those of the *Chalcotheke*. A bronze was discovered near it, and also an inscription bearing the name *Chalcotheke*. This building overlies an ancient cistern with

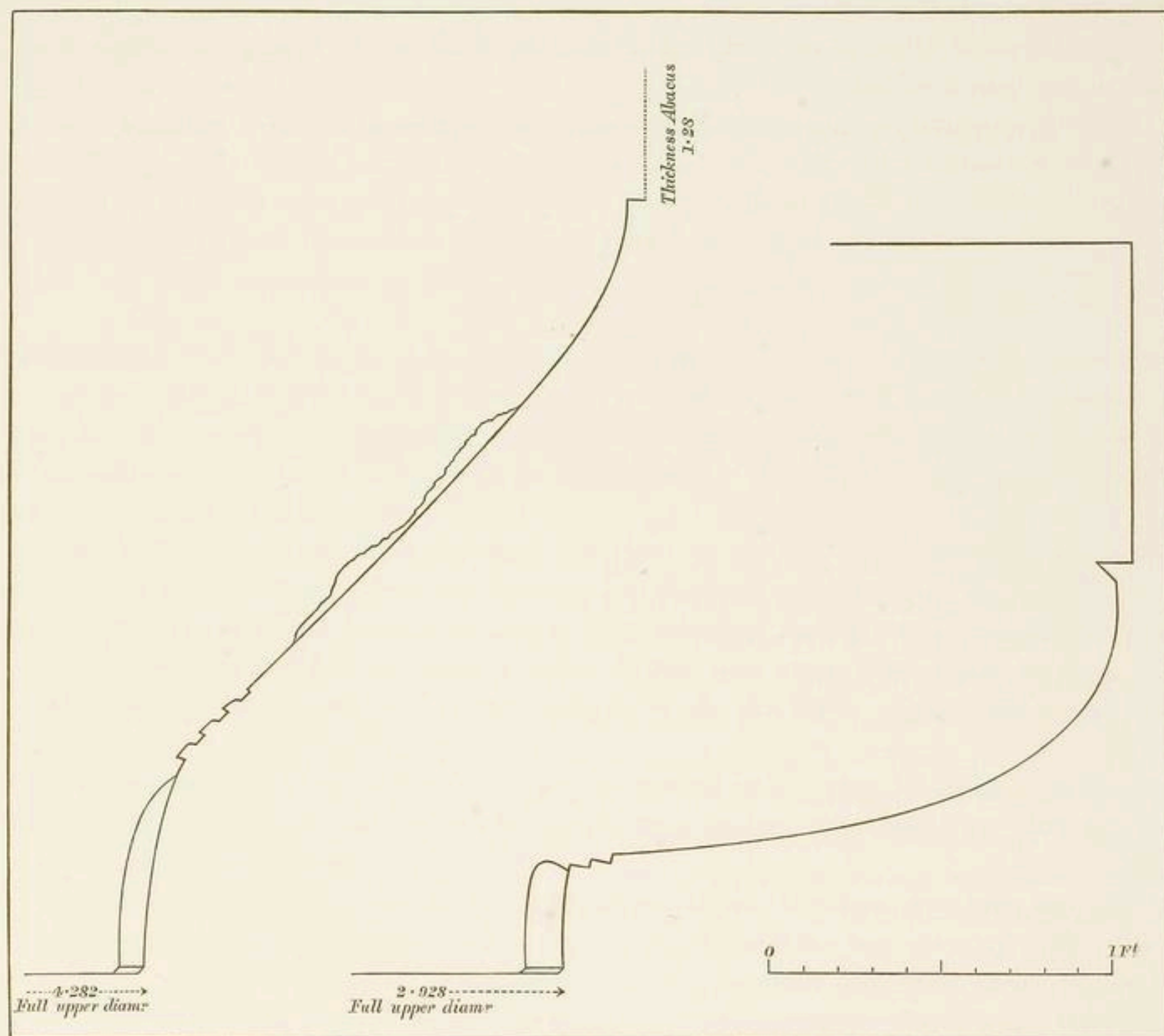


FIG. 1.

drainage works. The drains were closed up by the new walls, and diverted to another cistern, which will be described under the head of the Propylæa in Chap. X. Near the south-east angle of the Acropolis, where a small portion of a wall of Piraic stone was visible in 1846, just above the then surface of the ground, the foundations of a large building have been laid bare, measuring about 130 feet long by 52 broad. The front wall is comparatively thin, so the building was probably of no great height. It seems to belong to Roman times. Some marble fragments of a Doric pediment cornice of the Æginetan type, with coloured ornaments resembling some of those used in the Parthenon and Propylæa, had been built up in it. There is also near it a remnant of a Pelasgic wall, built to defend an unusually accessible part of the rock. Between these remains and the Parthenon the original surface¹ has been taken away, and a museum has been built to contain the sculptures and some of the more delicate architectural fragments, which from time to time are found on the Acropolis. South of the Parthenon is the broad foundation of some early building, which must have been concealed when the surroundings of the temple were completed. This wall is partly composed of Doric fragments of a still older date.

¹ That is as arranged when the Parthenon was finished.

The bearings of the principal buildings, as derived from astronomical observations, are as follows:—
viz. to a spectator looking east—

The Parthenon axis	12° 52' 41'' ¹	} North of due east.
That of the Propylæa	12° 31' 28''	
The Erechtheum	4° 50' 38''	
The Cecropium	9° 5' 0''	
Pedestal of Minerva Promachus	24° 54' 27''	

¹ The difference between this bearing as derived from the east end and from the north flank amounted only to 0° 1' 18'', showing the extreme accuracy to which the rectangle had been worked out.

CHAPTER II

ON THE ICHNOGRAPHIC PROPORTIONS OF THE PARTHENON

SECTION I

GROUND PLAN OF THE PARTHENON. PLATES III. IV. V.¹

PLATE III., which was prepared by Mr. G. Knowles in 1846, gives very exactly the present state of the building, showing the destruction and marks of violence which the walls, pavement, and columns, etc., have suffered; and exhibiting the traces of several crampholes and other marks, which have either originally or subsequently been formed on the pavement. In Plate IV. those marks only which appear to be original are retained.

Of the Hellenic traces the most important are those of the line of metal railing between the columns of the interior order, both of the Pronaos and Posticum,² and those of the pedestal of the chryselephantine statue in the Naos, with certain lines indicating that it was surrounded by a step and a railing; there are also traces of small pedestals varying from about 2 feet square to about 2 feet by 4, which occupied the middle step of the peristyles of the two flanks, opposite the centres of the columns.

The columns which still retain their full height are marked on the plans by a darker shade. Parts of others are standing *in situ*, and the remainder were, more or less, reinstated a few years ago under the direction of Professor Ross.

The attempt at restoration, however successful in one or two instances elsewhere, has here been attended by such an unsatisfactory result that no one will regret that it has been given up. The removal, however, of the mosque, and of other encumbrances from the pavement, adds much to the interest and dignity of the remains. It has also put an end to all doubts relative to the disposition of the columns of the Naos. Of these there are several traces on the south side and one or two on the north. Their axes (like those of the columns of the peristyles) are placed over the joints of the stones forming the floor or stylobate. One of these on the south side, near the site of the statue, where the real surface had been less worn than elsewhere, shows distinctly the contour of the Doric flutes,³ which were originally drawn on the pavement for the purpose of setting out the work, and can still be measured with accuracy. The full diameter of the columns was 3.656 feet.

These columns had sixteen flutes; and it is not unlikely that their situation in the interior of the building, where comparatively little light was admitted, may have influenced the choice of this number, which occasionally occurs in other Greek Doric temples, instead of twenty, the more usual number, and which prevails in the rest of the building. A portion of one of the antæ which formed the eastern termination still remains.⁴

¹ In these three plates, the south is placed at the top instead of the north, according to the more usual method. This has been done because the best and most obvious views of the Parthenon are from the north side.

² Further traces of this may be seen in Plate XVI.

³ A small fragment of, I believe, the lower drum of a column was found, whose flutes coincided with the above-mentioned traces.

⁴ In Plate III., it is suggested that the flank colonnades were finished towards the west by antæ, so as to assimilate the western intercolumniations with those at the eastern termination. It is due to Mr. Knowles to state that it was at my suggestion that he introduced these antæ into his plan. I have also adopted the same form in the small plan of the Parthenon in Plate II. The traces of the angle supports now existing upon the pavement are not sufficient to determine their plan. But I have since learnt

The small unshaded columns which are shown in Plate III. by the side of some of the larger on the south side of the Naos, appear to be the same which Stuart has given in his plan. The smaller columns had been substituted for those of the original structure when the temple was converted into a church.¹

In the opisthodomus the position of the columns is pointed out by four large slabs symmetrically placed in the pavement. The smallest dimension of these slabs is 5.3 feet. If we assume that these columns were Ionic, and similar to those in the Propylæa, the largest diameter which can be assigned to them cannot much exceed 4 feet, which is the measurement which Mr. Cockerell deduced from a circular trace, since obliterated, which he observed on the pavement. There are traces, at the door, of two channels formed by segments of circles 6.3 feet in radius, which seem to have been provided for the doors to traverse in.² There is no sufficient authority for supposing that there was *originally* any communication between the Naos and the Opisthodomus. The two doorways shown on the plan appear to have been later insertions.

The pavement is formed of slabs of marble more than a foot in thickness. In several places small stairs have been rudely cut in the deep steps of the stylobates, for the convenience either of the Christian congregation or the worshippers at the mosque, who by turns occupied the same spot in later times.

The very weatherworn state of the marble in many parts of the peristyles leads to the belief that the solid marble roof, with which they were covered, may have fallen in long before the calamity of 1687. The Posticum, which was not so much exposed as the Pronaos to the explosion, has suffered at that or some other period, by fire, by which the columns and lintel over the west door have been much calcined.³

The double line which is drawn in Plate III., immediately behind the columns of the peristyle, on the north, south, and west sides, denotes a rough channel which has been cut at some comparatively recent period to facilitate the drainage of the temple after the roof of the peristyles had fallen in.

Plate IV. is entirely devoted to the exhibition of the most important dimensions of the plan of the building.

These have been taken with great care, for the purpose of determining, as nearly as possible, the standard of measure of the Greeks, and also of ascertaining to what extent precise proportions prevail in this most harmonious structure.⁴

The measurements are given in English feet and decimals of a foot, a system which is recommended by its great facility of operation.⁵

that Mr. Cockerell found at the south-west angle distinct traces of a column, which he estimated to be 3 feet $3\frac{3}{8}$ inches: Mr. Joseph Woods also, who visited Athens a few years later, saw at the same spot faint traces of a column to which he assigns a diameter of 3 feet 9 inches (see *Letters of an Architect*, II. 251). The two statements are not irreconcilable, inasmuch as in the traces of those columns, in which the marks of the flutes remain distinct, there is also an inner ring of somewhat less diameter roughed out on the pavement. The dimension assigned by Mr. Woods, 3.75, is rather greater than that of the columns on the flanks: but the angle column of which he is speaking was probably rather larger than the others. In consequence of these authorities I have substituted the round form for the angular in Plate IV.

¹ Sir George Wheler, following the account of his companion Dr. Spon, says, "On both sides and towards the door is a kind of gallery made with two ranks of pillars, twenty-two below, and twenty-three above. The odd pillar is over the arch of the entrance which was left for the passage." This description agrees perfectly with the ground plan here given. On each side there are ten columns, and three on the western return. The central column of the lower rank had no doubt been removed, and the "arch of the entrance" substituted for it. Wheler says a *kind* of gallery, because, like the temple at Paestum, it was probably merely an architrave supporting the rank of columns, and not a *real* gallery.

² The radius which forms these arcs, = 6.3, is very nearly the measurement of the lower diameter of the columns of the peristyle. The centres or hinges were no doubt spindles, turning in sockets formed in the sill and lintel. The hole in the sill still remains. The doors, like the bronze doors of the Pantheon at Rome, probably had a fixed panel of about a foot in width between the hinges and the jambs; the latter are now about 16.2 feet apart, of hammer-dressed work; and, as well as the door cases, which appear to have been of wood, were probably coated with bronze.

³ Fanelli states a great fire was caused by the explosion. (Fanelli, *Athen*

Attica, 4to, Venezia, 1707.) An arch has been partly substituted for the lintel over this door.

⁴ It is only in a building of the character of the Parthenon, where the excellency of the workmanship is so remarkable, and the destruction from weather so trifling, that measurements can be determined with the minuteness of those laid down in this and most of the following engravings. In the measurement of modern or even Roman buildings, an attempt to obtain the original measurements of considerable distances to the thousandth part of a foot would be fallacious; but in a building of the best Greek workmanship it can be done satisfactorily, if proper care be taken to select such part of the surfaces for measurement as have been least exposed to the action of weather; for owing to the perfect jointing of the stones (the *ἀρμολία* of Pausanias, or the *ἀρμολ* of the Erechtheum inscription) the errors occasioned by any small shifts, which have arisen from earthquakes, or the violence of human agency, can be corrected most satisfactorily.

⁵ Should Government ever be induced to authorise the change from the duodecimal notation now in use, to the decimal, it can be safely affirmed that all the difficulties which are anticipated might easily be got over. It is true that the metre took a considerable time to become naturalized in France, but in that case the change was much greater than merely decimalizing the foot; it was equivalent to our introducing the yard decimally divided, as our standard. To propose an instance; one foot four inches and a half is readily conceived to be the same quantity with 1.375 foot, but it is by no means a simple operation to identify it with .458 of a yard; which is precisely analogous to the difficulty experienced by the French in changing from their *pied du Roi* to the metre. The foot is a far more convenient standard than the yard or metre, and the fact that $\frac{1}{16}$ or .01 foot = $\frac{1}{8}$ inch, very nearly, would facilitate greatly the change in the many small operations where ordinary accuracy only is required.

The name Hecatompèdon which was applied to the Parthenon,¹ has suggested the idea that the ancient measure of Greece is to be found in some of its leading dimensions. Stuart has treated this subject very ably,² and perhaps it would have been unnecessary to enlarge on it further, had he not been prevented, perhaps by the encumbered state of the Acropolis, from measuring the Parthenon with the same accuracy which he and Revett attained in the Temple of Theseus and elsewhere.

The quantity 101 feet 1.7 inch = 101.142 feet, which he has assigned as the breadth of the Parthenon, measured on its upper step, is not quite correct; and as I have myself taken great pains to ensure the utmost attainable accuracy, I may be allowed to state the case somewhat fully.

Pliny and other authorities inform us that the Greek foot was to the Roman foot as 25:24. By the best authorities the value of the Roman foot is confined between the limits .968 and .973 English foot. This would place the Greek foot between the limits 1.008 and 1.014.³ Niebuhr maintains that the length of the Roman foot, which he says, "cannot be doubted," was .972 English foot. This would give the value of the Greek foot 1.0125 foot.

The result of my own measurements of the breadth of the Parthenon, on the top of the upper step, is 101.341 feet on the east front, and 101.363 on the west. A small correction which these measurements have to undergo,⁴ determines the quantity 101.336 as the mean breadth of the building; this tallies, as exactly as the most scrupulous could have wished, with the result of the calculation, deriving it from the Roman foot. As a further confirmation, it may be stated that if the above be the true length of the Greek foot, the great staircase of the Propylæa is precisely 70 such feet in breadth.

From a passage in Euripides (Ion 1137) it has been suggested that as the sacred tent at Delphi is described as exactly occupying an area of 10,000 feet, the meaning of the word Hecatompèdon would be explained if some obvious dimensions of length and breadth could be found in the cella, of which the rectangular area should appear to occupy exactly 10,000 Greek feet. We are justified in expecting a result of about $(101.25)^2 = 10251.6$ square feet; but although this area is indeed contained within the space occupied by the cella, and its walls, its boundaries are neither the internal, external, nor yet the central lines of the walls,⁵ so that no result drawn from the area of the cella can be cited as exactly determining the point in question. There is not any other of the integral dimensions of the building which can be proposed for the maintenance of this hypothesis; and we need not hesitate in concurring with the many high authorities who have decided that the breadth of the Parthenon, measured on its upper step, is the 100 Greek feet intended by the name Hecatompèdon. For this I shall adopt the quantity 101.341 E.F., which is the measurement I obtained at Athens, from the east front; and proceed to the main proportions of the building.

It has been often noticed that the works of Nature, although usually their tendency is to be symmetrical, are seldom absolutely so; and when, in architecture, exact symmetry does prevail, a dry effect is not unfrequently produced. By the extreme care and refinement of their execution, the Greeks have produced, in an almost endless succession of accurate but varied proportions, that charm which is sometimes the result, but in a very inferior degree, of irregularity of design or even of workmanship. Many of these proportions are by no means of the most obvious kind; they are indeed at times so intricate,

¹ Leake's *Athens*, page 555 *et seq.* It seems to have been frequently stated, from I know not what authority, that the name Hecatompèdon was applied to the earlier Temple of Minerva destroyed by Mardonius. The ancient authors cited by Colonel Leake entirely disprove this supposition.

² 2d ed. II. 35, and III. 81.

³ See Appendix, art. 18.

⁴ The measurements were taken in favourable weather, the thermometer ranging from 10° to 11°9 Réaumur, with two steel tubular rods, each about 4 feet long, their actual value having been ascertained by a comparison with Messrs. Troughton and Simms's brass tubular standard, both before and after their having been used at Athens. It is remarkable that although the ends of these instruments were carefully protected with indiarubber, and the wooden box in which they were carried received no injury, they were each found to have decreased in length, between the two experiments, nearly .001 foot, which can be attributed to nothing else than the ordinary shaking they experienced on the road. Assigning to them a middle value during my operations at Athens, the breadth of the top of the upper step must be reduced on the east to 101.33, on the west to 101.352. Therefore the mean between the two fronts becomes 101.341. This again is subject to

a small deduction of .006 for openings in the joints (see a note in description to Plates X. and XI.), so that the absolute quantity is 101.335. In the engravings and text generally the small correction on the measurements has not been made. I should state that, in taking the measurements of the fronts and flanks of the temple, the thermometrical and other necessary corrections were duly attended to, and on measuring the breadth of the east front a second time for the purpose of verification, the result differed only by .001 foot.

I assume that the length of the building itself is almost invariable under small changes of temperature. Marble is known to be one of the least expansible of substances. The Royal Society of Edinburgh, in their experiments for the purpose of finding the best material for a pendulum, fixed upon Lucullite, a kind of black marble, which was found to expand only $\frac{1}{25000}$ of its length, between the freezing and boiling points, just $\frac{1}{4}$ expansion of iron. The expansion of Carrara marble was found at the same time to be $\frac{1}{12500}$, scarcely more than half that of iron.

⁵ The areas occupied by the cella, exclusive and inclusive of the walls, and by the centre line of the walls, are respectively 9135.1 square feet = $(95.578)^2$, 11201.2 square feet = $(105.835)^2$, and 10139 square feet = $(100.693)^2$.

that but for their almost perfect numerical correspondence, we could hardly have supposed them to have been intended. In a few unimportant details some irregularity is to be found, but the harmony of proportion in the main features is adhered to with an exactness truly wonderful.¹

The flank of the temple, measured on its upper step on the north side, is 228.141 feet.² Comparing this with the breadth, also on the upper step, taken at the east end, 101.341, we find a near approximation to the ratio of nine to four, which would have held exactly had the former been 228.016. I propose to account for this difference, which seems greater than can have arisen, in so perfect a building, from error of workmanship, by supposing that the columns of the Posticum were at first planned to be equal to those of the Pronaos, and afterwards, during the progress of the work, increased by .23 foot, as we now find them.³

The principal dimensions are as follows:—

	Measured.
Front, on the upper step	101.341
Flank	228.141
Length of the cella on the upper step	193.733
„ on the lower	196.383
Breadth of the cella on the upper step, measured in the Opisthodomus	71.330
Breadth of the steps of the Peristyle	2.325
Breadth of the step of the Posticum	1.39

The length of the Naos within the walls, 98.145 feet, or to the sills on which the walls stand, 97.710.⁴ The breadth, also within walls, 63.01.

In the inscriptions which have been discovered relative to the Parthenon, the word *ἑκατόμπεδος* is generally found in connection with *ναὸς* or *ναός*, and seems to be limited in its meaning to the Naos (see

¹ The small difference of .022 in 101 feet, which appears between the breadth of the eastern and western porticoes, points out the degree of error which may have arisen from inaccuracy of workmanship in the Parthenon; we may, therefore, always suspect some disturbing cause to exist, when in quantities which tend to equality or some obvious proportion, a difference sensibly greater than this, is found. With regard to the difference of .022 between the breadths of the two fronts, even wooden measuring rods are liable to a variation at least as great as this, from changes in the moisture of the atmosphere. I found during my measurements at Athens that some deal rods which I made use of in some of the measurements, and was accustomed to verify by occasionally comparing them with a known length on the building, varied as much as $\frac{1}{4000}$ of their length = .023 foot in 100 feet; so that if wooden measures were used by the Greeks, and we suppose that an interval of several hours elapsed between the setting out of the east end, and that of the west, during which time there had been a sudden hygrometric change, there would have arisen as much difference as exists, notwithstanding the utmost desire to render the Hecatompodon exact.

² We should observe that the length of the Egyptian foot, as determined by Mr. Perring and others, and especially confirmed by Professor Lepsius, is 1.142 English foot. The length of the flank of the Parthenon is very nearly a mean between $\frac{2}{3} \times$ the breadth of the front, and 200 Egyptian feet. The breadth, 101.34, is exactly a second of latitude at the equator. This is remarkable, and would have been a happy coincidence for Gosselin in his attempt to establish an identity between ancient measures and the size of the globe. A subject more recently followed up by Professor C. Piazza Smyth.

³ The observed data by which this hypothesis may be supported are as follows:—

1. The difference in the length of the flank from the exact ratio of $\frac{2}{3}$ of the front, by the excess of .125; a quantity so small as to make it almost certain that the ratio was intended, but too considerable to be accounted for, in the Parthenon, as a mere error of workmanship.

2. The difference of .13 between the breadth of the lower steps of the Pronaos and Posticum; the former being 1.26 and the latter 1.39, involving a difference of the distance between the upper steps of the peristyle and of the cella at the two ends.

3. The antæ being of the same breadth in the two porticoes, notwithstanding the inequality of the columns, unusually small if compared with the larger columns (those of the Posticum), but exactly proportioned to the columns of the Pronaos. For their breadth is equal to the diameter, within the flutes, which agrees with the rule followed in the majority of cases in Greek Doric; among which may be cited, the Temple of Theseus; the smaller order of the Propylea; the Naos of the Parthenon itself; and a considerable number of other examples given in the *Unedited Antiquities of Attica*. The breadth also of the small step under the antæ, of which

the measurement, obtained in the Posticum, is 5.403, seems to refer them both to the proportions of the Pronaos, where that dimension is the full diameter of the column, the width of the upper step being practically the same in the two porticoes. Owing to the ruinous state of the antæ themselves in the Pronaos, a direct measurement of the eastern faces could not be obtained, but the small faces on the flanks are identical with those of the Posticum, and the equality of the N. and S. dimensions of the stones forming the pavement, in the two porticoes (see Plate IV.), seems to establish the identity of their eastern and western faces.

4. The difference of .174 (see Plate XVI.) observed in the front and return soffits of the epistylia in the Posticum; the former being 4.84, and the latter 4.666; showing a want of correspondence between the antæ, and the larger columns.

It is difficult to imagine any advantage derivable from the difference in the diameters of the columns mentioned above, unless it were an improvement introduced into one variety, after some defect had been observed in the appearance of the other, which had been already executed; defects which we may be sure the intelligent supervision of Phidias and Ictinus would be as ready to seize, as they would be certain to remedy. We may therefore inquire whether this consideration will not furnish an hypothesis capable of explaining the above irregularities.

Let us then imagine a period of the work, in which the cella together with the antæ at each end, and the prostyle portico of the Pronaos (doubtless the parts first finished) was nearly completed, but the rest of the work not yet set up; although probably the greater part of the material was prepared; and that it occurred to the architects that the columns of the Pronaos (which are more than six diameters high) appeared too slender. Under these circumstances let us suppose that it was determined to add .23 to the diameter of the columns of the Posticum, while it was considered inexpedient to reduce the intercolumnium, or space between the angle columns and the antæ. The whole step would therefore have to be thrown forward westwards by the above quantity. But we may also presume it was not thought desirable, having regard to the general proportion between the front and the flank, to lengthen the latter by so large a quantity as .23, and while the upper step was thrown forward to that extent westwards, it was drawn backwards at the east end by about half that amount, and without altering the peristylar space or ambulatory (which has been made rigorously equal at the two ends of the temple), simply by reducing the lower Pronaos step to 1.26, while the step of the Posticum was used of the dimension originally contemplated. The narrower columniations of the flank near the east end may be noticed in connection with this explanation.

⁴ The measurement given in the plate is 98.08. This is taken from the transverse wall to the little step projecting .065, caused by the return of the impluvium under the wall of the Pronaos.

Boeckh, *Corpus Insc. Græc.*, vol. i. 177) in its restricted sense, in which it is used above. The dimension above given is perhaps a sufficient approximation for a general statement, but there can be little doubt but that the front of the temple, which was always accessible for reference as a standard, was the true Hecatompædon in point of exact measurement.

The length of the Opisthodomus within the walls is 43.803.

The interval between the opposite columns of the Naos, measured between their full diameters, is 32.591, = $\frac{1}{2}$ flank; for $\frac{228.141}{7} = 32.591$, or $\frac{228.016}{7} = 32.574$. The breadth of the *impluvium*, or space contained within the small raised step supporting the columns of the Naos and the wall of the Pronaos follows from the last dimension and amounts to 32.233 feet. The length is 83.446, and terminates towards the west at a distance of 14.645 from the transverse wall of the Naos.

The breadth of the abacus of the columns of the east front is exactly $\frac{1}{15}$ th of the breadth of the temple on the upper step, and measures 6.756 feet. The measured lower diameter of the columns of the peristyles is 6.249.¹

The measurements which follow, relate to the Ichnography, or plan of the building.

The average *columniation* (if I may be allowed so to call the interval between the centres of two adjacent columns) is 14.098 feet at the east end, and 14.083 on the north side.

Mean total projection of the stylobate	4.985
The peristylar space or ambulatory fronts	15.88
" " flanks	13.97
The full average diameter of the angle columns from fillet to fillet	6.388
From the lower step of the cella to the low plinth supporting the Pronaos wall	19.040
" " " Posticum	18.72
Thickness of the Pronaos and Posticum walls ²	6.760
Breadth of antæ of the columns of the Naos	3.563
Diameter of the columns of the Naos	3.656
Average columniation	8.550
Breadth of the line of slabs supporting the latter (mean)	4.008
Partition wall of the Opisthodomus, thickness	3.025
Thickness of the lateral wall of the cella	3.830
Ditto above the first joint	3.804
Ditto at the top of the wall	3.760
Full diameter of the columns of the Posticum (inner order)	5.632
Ditto of those of the Pronaos	5.402
Breadth of the northern anta of the Posticum, West face	5.033
" " South face	5.023
" " North face	1.560
Upper faces of anta under the course which contains the capital, West face	4.745
" " " North face	1.495

It only remains to notice the projection of the basement on the south side. This is 10.24 feet measured from the top of the upper step to the extreme surface of the rusticated work, and 10.14 to that of the lower fair worked channel. (See Plate IX.) This latter quantity was perhaps intended for 10.134, viz. 10 Greek feet; but it is remarkable how seldom the foot or its sixteenth part, the dactyl, occur in integers throughout the Parthenon.³

The ratio of the voids to the solids at the level of the pavement, both in the peristyle and in the cella, is about 18,934 square feet: 4186, which is equivalent to 9:2 very nearly.⁴

¹ The measurements which I obtained of the lower diameter of the columns of the peristyles are 6.251 feet from the west end, 6.250 from the north side, and 6.245 from the east end, being in each case the average of all the columns which could be measured. These are the full diameters from fillet to fillet.

² It is well to observe the happy management of the different walls of the cella. Those which are pierced with doorways are thickened, that they may appear to be very strong, while the others have no more substance than

is necessary for construction.

³ The breadth of the tegulae or tiles forming the ridges or coverings to the *κεραμίδες* or imbrices, .76 foot, = 3 palms, is almost the only clear case, which I noticed in the Parthenon of the use of the subdivisions of the foot.

⁴ The only unknown quantities which effect this result are the diameters of the columns of the Opisthodomus, and the precise original amount of the openings of the doors of the Pronaos and Posticum, both which however are known approximately.

Plate V. is a plan of the upper members of the Parthenon showing the measurements of the abaci of all the existing columns, together with the positions of the marble beams which at one end connect the entablature of the inner order of the Posticum, or western portico, with that of the peristyle, and on the other with the Posticum wall. The general arrangement also of the ceiling of that part of the temple¹ is given in dotted lines, as far as it can be made out from the traces which remain on the beams and on the cella walls, with the help of fallen fragments. The architraves, where existing, are shown by the double lines over the abaci of the columns.

The dotted lines drawn east and west partly across the Opisthodomus show the positions, projected on the plan, of the longitudinal beams or purlins which formerly supported the roof; these are given in Plate XVI., as if they were of timber; but from the large size of the recesses provided in the western gable for their insertion, it seems as reasonable to suppose that they were marble (excepting of course over the Naos, which, if roofed at all, must have been covered with framed timber). Their positions coincided with those of the marble beams of the peristyle. Four of them were directly supported by the cella walls, and by the columns of the Opisthodomus, and three by the architraves over those columns.² The roof over the Naos would of course be subject to modifications arising from the arrangements for light.³

SECTION II

ON THE ELEVATION OR ORTHOGRAPHIC PROPORTIONS OF THE PARTHENON

SEE PLATES VI. VII. VIII.

PLATE VI. is an isometrical sketch or diagram, showing the upper surface and sides of every abacus at the east end, and of those at the angles of the west front; giving the breadths and thicknesses of the abaci, and the positions of the architrave upon them. It exhibits these parts in their actual state when measured, with the amount of all such cracks and other displacements which the stones have suffered, as are necessary to be taken into consideration in estimating the precise original form and length of the architrave.⁴ In this plate, owing to the large scale necessarily adopted, the continuous line of the columns has been broken; and the 3d, 4th, 5th, and 6th abaci, the numbers reckoning from the north-east angle, are given within the bracket at the bottom of the plate.

Plates VII. and VIII. give the measurements of the entablature of the eastern end, which are also separated into two plates on account of the large scale adopted.

At the bottom of Plate VIII., in the left-hand corner, is given a section with measurements by level and plumb-line, of the basement at the southern angle of the east end; the measurements of the northern angle are given on the right-hand corner of Plate VII.⁵

At the bottom of each of these plates are given the ichnographic projections, by plumb-line, of the abaci of each column, with the distances of each extremity of the said projections measured back from the edge of the upper step.⁶ Two measurements are required for this purpose, because the abaci have generally been more or less twisted by the concussions the building has received.

Higher up in the plate are represented the joints, under each column, of the stones forming the upper step, showing that these are exactly under the centre of each column, or very nearly so, and that they incline to the south on the southern half of the front, and to the north on the northern half; that is, they have been constructed perpendicular to the upper surface of the step, and consequently form, as

¹ There is no reason to suppose that there was any difference in the ceiling of the Pronaos, but no traces or fragments of it could be found.

² The mass of masonry of most rude work, mentioned by Wheler and Spon, see Stuart, 2d ed., vol. ii. p. 25, and of which the remains are shown by Stuart in his ground plan, lettered *ee*, falls exactly under the southernmost of these beams, so that it appears that one of these had been recently under repair when those travellers visited Athens.

³ I cannot forbear directing the reader's attention to a highly ingenious solution of this enigma by Mr. Fergusson in his *Principles of Beauty in Art*, p. 387, which seems to be the best arrangement yet proposed. Still it

cannot be said to be so certain as not to require a further confirmation drawn from bas-reliefs, medals, etc., or what would be still more conclusive, the discovery of fragments of the clerestory windows, such as he supposes. Since the above was written Mr. Fergusson has carried the investigation much further and supported it with very powerful arguments. See especially his work *The Parthenon*, 4to, Murray, London, 1883.

⁴ See below, p. 16, note 1.

⁵ Sections of the basement at the west end are given in Plate IX.

⁶ Where the abacus has been broken the deficiency has been supplied by calculation.

it were, the joints of an arch which approximates to that curvature of the step, which will form the subject of the ensuing chapter.

The lower and upper drums or stones forming the columns are also given, with measurements taken in the middle of each of the four flutes, towards the cardinal points, wherever they could be satisfactorily measured.

These unequal measurements of the upper and lower drums (for the joints of all the others are at right angles with the axes of the columns, as sketched in the diagram in Chapter IV.), explain the long misunderstood *scamilli impares*, literally unequal footstools, of Vitruvius, which we shall have occasion to mention hereafter.

The plumb-line is shown as dropped from each abacus, on the north, south, east, and west sides, giving the departure of the vertical faces of the abaci from the perpendicular,¹ and various instances of the distance of the centre of each flute at the neck of the column, from the same line. These dimensions were obtained by spirit-level and plumb-line, and never, except in particular cases, *boned* or squared from the lines of the architecture.²

The lengths of the architrave stones are given in almost all cases; the plumb of their joints, or else the differences of the length of their upper and lower lines are also given. These departures from the perpendicular are so small, that it is evident that the joints of the architrave were intended to be plumb.

The shifts or separations which now exist in such of the vertical joints as are open, and the breadth of the cracks in the architrave stones, are likewise given, so that the entire original length of the architrave, etc., may be obtained. The measurement of the triglyphs and the present widths of the metopes are also given, as well as the actual heights and plumbs of the entablature in three different parts of the front. The position of the holes for the shields, which at some uncertain period were affixed to the architrave, and traces of the margins of some of the shields are likewise represented.³

Lastly, in Plate VII., on the left-hand side, a portion of the upper bed of the frieze is shown, with the manner in which the contiguous stones are cramped together with iron, let into the marble, and run with lead. Besides these there are studs of iron, which serve to join the stones in the different courses to those above or below them.⁴

We may now trace the principal proportions found in the Orthography or Elevation, as we have already done in the case of the Ichnography or Plan. The most important of these is the entire height of the building to the top of the cymatium of the pediment; this is 58.902 feet above the upper step in the centre of the front (see Plate XVI.), and if to this be added the quantity .225, the increment or rise of the middle of the stylobate above its angles, owing to curvature,⁵ we obtain 59.127 feet.

The height of the angle columns of the peristyle is 34.253. The columns in the middle of the front or flank being 34.218.

The height above the pavement, attained by the columns of the inner order, is determined by adding to the columns of the peristyle one thickness of the external abacus.

The varieties in the breadth of the abacus in different parts of the building may be thus explained. When we observe that the largest are those at the east front, the smallest on the south side and west end, while those of the north flank are of various sizes and decrease from east to west, but not according to any obvious law, we may suppose that the architects considered the normal proportion best suited to a level area was the largest of these, viz. that given to the capitals of the east front. We may further presume that they were induced to give an exact modulus of $\frac{1}{15}$ of the breadth of the building to those of the eastern

¹ In this description and what is about to follow I must beg it to be understood that when a line or surface is stated to be *absolutely horizontal* I use the word *level*, while I mean by *horizontal* the word used in its ordinary acceptation. Also when a line is *perpendicular*, I use that word, or the word *plumb*; a line which may differ very little from the perpendicular I call a vertical line. Thus I would call the pavement of the temple *horizontal*, although it is not level; and the axes of the columns vertical, although not perpendicular.

² This, however, does not refer to measurements where the absolute length only of a line, without reference to position, is what is meant; such as the breadths of the abaci, lengths of the architrave stones, etc., which are measured along the architectural lines.

³ See also Plate XXII. These shields are said to have been presented by Alexander the Great; they were certainly attached to the temple with greater rudeness and irregularity than is likely to have been used by the original builders of the Parthenon. It is probable that two of these shields, between the 3d and 4th columns, were removed at an early period, when the temple was still an object of respect; for although their traces are as apparent as those of the others, the mortices have been neatly filled up with marble plugs.

⁴ Comp. Plate XVII.

⁵ I must for the present assume the point of curvature, reserving its full demonstration for the ensuing chapter.

or most sacred front.¹ Again, owing to the position of the southern and western capitals with regard to the eye of a spectator, who would always view these very much from underneath, they would be liable to appear larger and more overhanging than those of the eastern and northern colonnades, which could be seen in less quick perspective.² In addition to these considerations, we may observe that in the refinement of the Greek Doric the tendency was constant to diminish the great spread of the archaic capitals. From these reasons we may infer that the architects to whom the building of the Parthenon was entrusted, weighing every circumstance that could affect the appearance of the building as first designed, probably considered that the amount of projection which was required for the echinus of the eastern front, would appear too heavy when seen from such points of view as the western approach and the area to the south of the temple afforded. They accordingly diminished the spread of the echinus of the columns of the southern and western peristyles, while they varied the dimensions of the capitals of the north side, so as to accommodate them to the nature of the ground, which rises considerably from west to east.³

TABLE OF THE BREADTHS OF THE ABACI.

	Measurement.	Calculated Value.
From the East End, and S.W. angle, general average .	6.753 $\frac{1}{2}$ upper step	6.756
From the angle columns, Eastern Front .	(N.E. 6.858) (S.E. 6.855)	$6.756 \times \frac{6.6}{6.5}$ 6.859
Western front, angle columns .	(N.W. 6.757) (S.W. 6.718)	6.756×1 $6.756 \times \frac{1.79}{1.80}$ 6.756 6.718
Average from the South Flank ⁵ .	6.570	$6.756 \times \frac{3.5}{3.6}$ 6.569
Average from the West Front .	6.578	$6.756 \times \frac{3.7}{3.8}$ 6.578

It is unnecessary to follow out all the varieties of the capitals of the north flank, one of them is the subject of a note in the preceding page; the second from the north-west angle was perhaps made larger than those adjacent, on account of its proximity to the larger abacus at the angle. Of the remaining capitals of the north flank, seven examples at Athens, and one in the British Museum, are sufficiently alike to justify an average from them being taken, of which the result is 6.611.

The abaci of the columns of the inner order

	Measured.
Pronaos	5.604
Posticum	5.762

The pediment of the Parthenon rises very nearly 6 in 25. The height of the pediment, including its corona and the increment of curvature (that is measuring the height from a straight line joining the extreme points, instead of from the horizontal cornice as actually built), is 12.643 feet, or, with the cymatium added, = 14.078—one columniation—above the level line, and the length of the horizontal cornice, including the mouldings of the corona, = 104.634 feet, or 104.276 feet measured at the bottom of the corona; and .016 more at the top.

¹ There are some slight differences in the capitals of the Theseum, where also those of the east end have the exact modulus of $\frac{1}{2}$, the breadth of that temple. See Chap. XI.

² The greater strength of the light on the south side may be thought to have influenced the Greek artists in making the capitals on this side less than those on the north; but that could not have caused the difference between the east and west fronts.

³ The abacus of one of the fallen capitals on the north side is 6.746 feet broad. In this example the distance of the echinus from the face of the abacus produced (viz. CA Plate XIX. Fig. 1) is .073, instead of the ordinary dimension of .063 foot, so that the abacus was left .02 wider than at first intended. I have no hesitation in assigning its position to the fifth column from the north-east angle near to which it lies, where the intercolumniation on each side being for some reason or other unusually great (see Plate IV.), it was thought desirable to reduce, although by so delicate an accommodation, the difference between these and the contiguous intercolumniations, which otherwise in the architrave might have seemed too palpable. The amount of this adjection testifies, quite as much as their attention to the circumstance itself, the artistic propriety of the Greeks.

An architect of a less careful school would probably have either omitted the adjustment altogether, or *humoured*, as it is called, the capital to a greater extent. The Greeks, however, understood the value of *ne quid nimis*.

⁴ The south side of the temple, owing to the action of the sea air and winds, has in many parts lost its original surface. This degradation, however, seldom exceeds from about .003 to .005, and there are occasionally harder points in the material which can scarcely, if at all, have suffered. The east end is generally very little worn, and its harder points may generally be accepted as the original surface. The north side has been almost entirely protected by the growth of a lichen, called by Mr. Woods the *lichen candellarius*.

⁵ A reason will be given in Chap. VII. for supposing that the capitals of the south side were reduced about .036 from the breadth which they were intended to have when first the echinus was turned. If this quantity were added, the measurement would become 6.606; which agrees very well with that of the capitals of the western half of the north side. So that it appears possible a second accommodation to their position was made after the works were commenced.

The length of the architrave on the fronts is less than the upper step by the average quantity 1.113,¹ viz. 1.117 from the west, 1.110 from the east end. The quantity intended was perhaps 1.126, which is one sixth of the eastern abacus or one ninetieth of the upper step; so that the ratio of the architrave to the step would be $\frac{8}{9} \frac{9}{10}$.

The semi-diminution of the columns at the east end is .683, at the west end .685. This is exactly one fiftieth of the height of the column, viz. $\frac{34.253}{50} = .685$.

Measured heights, etc.

The average height of the two lower steps of the Stylobate, which are evidently intended to be equal	1.693
The small lower step which has the effect of giving scale is evidently half the great lower step	.858
The upper step ²	1.814
The two steps of the cella taken together	2.291
Capital of the columns of the Peristyle	2.833
Of which the thickness of the abacus	1.149
Height of the architrave ³	4.425
Thickness of the architrave measured at the east front	5.836
Height of the Frieze	4.417
Architrave and Frieze of the Posticum together	6.748
Thickness of the architrave over the columns of the Posticum	4.840
Ditto over the antæ	4.666
Total of combined height of entablature in front	10.793
By adding fillet of cymatium on flanks	11.118
The breadth of the beams at the top ⁴	3.750
Thickness of the external horizontal cornice	1.951
Thickness of the raking cornice over the pediment	1.174
Perpendicular height of the cymatium	1.430
The general breadth of the triglyph	2.766 ⁵

The commensurabilities which may be found in many of the details entirely leave us when we come to examine the breadths of the different metopes. The following are the breadths of those on the east front, beginning with the northern metope. The measurements are taken at the bottom of each, deducting all cracks and shifts which have affected them, 4.160, 4.066, 4.064, 4.050, 4.282, 4.295, 4.320, 4.375, 4.169, 4.186, 4.195, 4.192, 4.120, and 4.121. This last is the southernmost.

The only law of these differences that can be suggested is that the metopes, always rather broader than they are high,⁶ are broadest towards the middle of the front, being there about $\frac{1}{10}$ of their height. This arrangement gave space for larger groups in the metopes under that part of the front where the figures in the pediment were the most important. At any rate we can hardly suppose that these differences arose from want of communication between the architects and the sculptors employed upon the metopes, although in the case of the fourth from the north-east angle the sculptor certainly exceeded the breadth which was provided for his group.⁷ But, observing that almost in every case the centre of the triglyph is placed exactly over the joint of the architrave, either we must suppose that the breadth of the metopes determined the length of the architrave stones, or *vice versa*. I have

¹ I endeavoured in the east front to obtain the length of the architrave, first by the actual measurement of the separate stones, and secondly by obtaining the difference between its length and that of the step by means of the plumb-line, taking into account such cracks and shifts as affect the estimate of its original length. The difference given by the former method amounted to 1.118 foot, by the latter 1.107. But as the base in the latter case was measured with greater convenience, and the plumbs were carefully taken several times over in calm weather, I give a certain preference to the latter method in taking their average. The length of the architrave of the west end was obtained solely by measurements of the step, and by plumbing. On the flanks the quantity is 1.05 foot of which .58 is set back at the west end, and .47 on the east. But we may be satisfied that the proper length was determined on the fronts rather than on the flanks of the building.

² These four steps have the following proportion amongst themselves, beginning from the bottom, 7, 14, 14, 15. Their combined height is 6.058.

³ The thickness of the architrave band is $.375 = \frac{1}{8}$ of the abacus. So that the height of the face of the architrave is 4.050.

⁴ In forming this average one beam, which has for some cause been made smaller than the rest, has been omitted.

⁵ There are a few variations, for instance that at the north-east angle is 2.786 feet, and one on the north side is 2.79.

⁶ In the oldest examples, metopes seem to have been usually square, but in the Temple of Theseus and the Parthenon the width exceeds the height.

⁷ See Plate VII. The metopes which were worked separately, perhaps at a distance from the building, were let down into a groove prepared between the triglyphs, before the cornice was fixed. Comp. Plate XVII.

been assured by Mr. Edward Riedel, the Bavarian architect, surveyor to the Royal Buildings at Athens, that in building the palace of King Otho extreme difficulty was met with in finding in the Pentelic quarries stones even of a far less scantling than that of these architraves. We see also that in the Temple of Jupiter Olympius, where stones of very great size were required for the architraves, a different and much coarser marble has been used than that found in the Periclean buildings at Athens. We may consequently infer that stones of 14 feet long and upwards were very rare, and that if all had been reduced to the length of an exact columniation, it would have been almost impossible to obtain a sufficient supply for the architraves. But by using some which were rather more and others rather less, the whole length was made out. If we also suppose (as is likely) that no part of the architraves were fixed until the major part of the stones were obtained,¹ the differences of the flank intercolumniations on the plan² may be also referred to this cause. But to whatever motive we may attribute these varieties in the intercolumniations and metopes, we learn that in the frieze of the Parthenon the Greek architects did depart somewhat from that strict regularity of proportion, of which abundant examples may be found in the plan and elevation of the temple. These varieties may have been thought useful in harmonising with the play of line and light on the sculptured metopes.

In this and the preceding section of this chapter I have merely enumerated the dimensions and principal subdivisions of plan and elevation which formed the architectural features of this temple, by common consent the most harmonious structure ever built. It is natural that we should inquire into the proportions by which so remarkable a result has been obtained. In the first edition I endeavoured to point out the relation of one part to another. In a few instances where this was obvious I succeeded, and generally was able to show that a partial reduction of the compared dimensions to lower terms by means of the diameter of the column was effected, but nothing approaching a general law was arrived at. It is now quite unnecessary for any such imperfect attempt to be repeated on account of the complete and happy solution by Mr. W. W. Lloyd of the scheme by which the proportions, both of this temple, and most if not all the works of the best time were regulated, of which a fuller statement will be found in a memoir written by himself, of which he has permitted the republication in this volume; and I will here only observe that of various methods which have been brought to my notice for accounting for the proportions of the Parthenon, although occasionally one or two lucky hits might be claimed, none except that discovered by Mr. Lloyd have stood the test of being universal as respects the main architectural features of the Parthenon and Theseum, and generally also of the Propylæa, and at the same time accurate to the last degree, and, besides this, affording a rule by which an architect could work without being hampered in the freedom which is necessary both for convenience and artistic effect. The reader is referred to the Appendix, Art. I., and also to an essay by the same author in Mr. Cockerell's beautiful work on the temples of Ægina and Bassæ,³ as to its application to the last-named temple, and also to the *Ionian Antiquities*, Part IV.,⁴ which contains a contribution from Mr. Lloyd with reference to the proportions of the Temple of Minerva at Priene.

SECTION III

DETAILED DESCRIPTION OF THE SUB-BASEMENT OF THE PARTHENON. SEE PLATE IX

THE lower part of this plate represents an elevation of the basement of the west front, whilst on the upper part are given elevations of the two extremities of the south flank of the Parthenon. The

¹ To prove this hypothesis, which of course assumes that all or most of the materials for the work were at hand before the actual structure was commenced, we need not insist on the building of Solomon's temple being a parallel case, where all the stones were certainly prepared at a distance, and in all probability before the building was commenced; but it appears from the Erechtheum inscription that almost all the material required for that temple was on the spot at the time the survey it commemorates was taken, although some portions were not yet fixed and the carving and polishing of the work were for the most part unfinished.

² These differences are not so considerable in the fronts as in the flanks:

on the north flank the greatest difference is between the second and the fourth intercolumniations from the eastern angle, where it amounts to .136 foot. In the fronts .02 foot is the greatest at the east; and .037 on the west. A difference of this amount might have arisen in working the step itself; as from the rubbing of the stones together in order to obtain a perfectly fine joint (see Chap. III.), some stones would be liable to be worn down more than others, and slight variations would thus arise.

³ *The Temples of Ægina and Bassæ*, fol.; London, 1860.

⁴ *Antiquities of Ionia*, Part IV.; published by the Society of Dilettanti, 1881.

intermediate portion contains, on the right hand, the eastern part of the south flank drawn to a larger scale; and adjoining it is a portion of the rustic work still further enlarged; on the left hand is a section of the basement taken in the middle of the west front. At this point a heap of rubbish gives access to the three high marble steps of the stylobate. These steps are now subdivided, having been rudely cut into a sort of stair about 8 feet wide (see Plate III.), which was probably done when the temple was converted into a church. In ancient times it is clear that the access to the temple at each front was facilitated by the introduction of the small steps, of which the traces are here indicated by a darker tint. They are shown in plan in Plate IV. in dotted lines, as also in section in Plate XVI. These steps exactly occupied the breadth of the columniation. It will be seen that there is a course of masonry varying from .99 to .89 thick, immediately below the three great steps of the western stylobate. On the west and north sides this course is entirely of Pentelic marble; at the north-east angle it is .858 thick, and after turning round the corner on the east front it diminishes to .585 and falls back into the front, as shown in Plate IV. Its place is there occupied by the solid rock, which for a short distance carries the steps, but this soon failing, the foundation is formed of Piræic stone. On the south side, see Plate VIII., the small step reappears, of the last-mentioned material, and .43 in thickness, which it retains with small variations until near the west end, where it resumes its original thickness, and again is formed of Pentelic marble. The Piræic stone part of it along the flank is worked out of the same stone as the three fascia moulding shown in the Plate.¹ All the courses below this are of Piræic stone, excepting three blocks which form the foundation of the north-west angle. That immediately beneath it at the west end is a thin course varying from .876 to .96 in thickness, having at the bottom a rough notch or projection, which must have served to carry the external pavement in front of the Parthenon. The two courses below this are well finished, and one of them carefully rusticated, and there can be little doubt that they were originally intended to be seen, and formed the basement of the earlier Temple of Minerva destroyed by the Persians. Immediately below them probably came the line of the pavement in front of that temple. Underneath the rusticated masonry on the south side are two courses of rough work, but their projection is not generally so great as that noticed above.² These must have been intended to serve some purpose in the more ancient structure. Perhaps the lower level was the line first intended for the pavement, the upper that ultimately adopted.³ Some chiselled marks on this sub-basement, from which important deductions may probably be gained, will be referred to in Chapter XIV.

The pavement of the area surrounding the sub-basement of the Parthenon, though on the west it was evidently on a higher level than that in front of the earlier temple, on the southern side may have coincided with it. There is a marked difference between the character of the masonry used in the complement (or continuation required to make up the length of the new and larger temple) on the south side eastwards, and that on the west end northwards. In the former case the rustications are continued and executed with the utmost perfection; in the latter the joints and beds only are carefully worked, the surface is not smoothed, and not only are the depths of the courses irregular, but the stones do not in every case break joint. From this it may be supposed that the courses spoken of at the east end of the south side were exposed to view, while those at the north end of the west front were hidden by the pavement.⁴

All the measurements of the lower drums of the columns of the west front which could be accurately obtained are given. These differences (*scamilli impares*) are measured in the centres of the north, south, east, and west flutes of the columns.

¹ This moulding does not occur on the west or north sides. It was evidently part of the original sub-basement, and was shifted, altered, and adapted to the new construction. At the eastern extension it has been partly worked out of the solid rock, and when the rock disappears it is continued in Piræic stone, until it comes to a termination near the west end on the south side. It seems to have been intended that it should occupy the whole breadth of the east end, but the sinking in the rock, out of which it is formed, northwards of the second column above-mentioned, is unfinished, and only just traced out.

It may have been intended that all the rock which appears above the level of this moulding eastwards, and which is inconsiderable in amount, should have been lowered for the reception of a marble pavement; but this, as well as several of the last finishings, remained imperfect.

² These projections on the south side do not form so uniform a rebate as

on the west, in some places they merely seem to be such roughnesses as might be left in the finishing of the surfaces of the masonry.

³ This seems to be confirmed by observing that the made ground at the level of the lower line is composed of chips of the Acropolis rock, whilst the upper line corresponds with a level of made ground of chips of Piræic stone, of which material the earlier temple was chiefly built. Had the upper projection been provided for the Parthenon, either by sinking back a surface hitherto left rough or letting in new stones, we should have expected a made ground of chips of Pentelic marble, as may be found at the Propylæa and other places.

⁴ It is clear that the pavement in front of the existing Parthenon had its level on the east, north, and south sides at the bottom of the small marble step, but it is less easy to determine its level on the south.

It may be here observed that the several courses of the basement which we have shown to have belonged to the earlier temple, as well as those of the stylobate, are built in curved lines; that is, the line shown by each horizontal joint on the face of the wall is a plane curve, and rises a little in the middle from an imaginary straight line drawn from one of its extreme points to the other. This *adfectio per medium* (Vitruvius, III. 3) will form the subject of the next chapter.

SECTION IV

MORE RECENT NOTES ON THE PARTHENON. PLATE IXA.

THE floor of the Parthenon has now been entirely cleared of the mediæval constructions which formerly encumbered it, and traces may be seen of circular grooves in which the doors of the Pronaos traversed, but they are much less conspicuous than those of the Posticum. There are also indications of two small folding doors in the wall separating the Naos and Opisthodomus.¹ The doors, which are shown on Plate IV. and more at large in Plate IXA, had this peculiarity, viz. the two valves opened different ways. Describing first the northern of the two doors, and looking west, it is to be observed that there are scratches on the pavement of the Naos arising from traversing of the northern or right-hand valve only, whilst the bolt holes to which the left-hand valve was secured when it was shut, have been worn, or rather violently forced in an opposite direction. The sockets for the hinges remain in all the cases, but one on the north side has been renewed with new stone apparently after rough usage. As respects the southern of these doors, the pavement is not so well preserved as at the northern, but it evidently corresponded *mutatis mutandis*.

The reason for the peculiarity of these doors probably arose from want of room to open both valves towards the Naos. Mr. Fergusson in his restoration of the Parthenon has placed against this wall and on the side towards the Naos the staircase required for access to the roof, and this arrangement of the doors certainly favours that disposition. It seems quite evident that these doors were not part of the original design, because the cuttings for the original cramps of the wall were exposed on each of the thresholds. The rough irregular channels shown on the plan were produced in the endeavour to extract the iron cramps or stubs by cutting into the wall while it was yet standing.

Amongst the fragments now lying in the area of the temple are some which have evident connection with the history of some of the changes to which the Naos has been subjected. Looking at the plan given in Plate III., we see traces of two distinct ranges of columns on the low impluvium step which bounds the central area of the Naos. One, the original Doric order, having sixteen flutes already referred to; and the other, the more recent colonnade which Spon and Wheler saw and described. The former may have been injured by fire at some period and the latter substituted when the temple was converted into a church, as more open and suitable. I was unable to determine the measure of the columniation of the easternmost bay of these interpolated columns, but the general average is about 8.16 each. The original columniation was 8.55.

On the top of the plate is shown a Doric entablature which occurs amongst these fragments, and of which the length 8.21 conforms to the reduced range, whilst the feeble character of the detail assigns it to a late period, which, however, still retained something of the classical tradition; in fact somewhere between the time of Constantine and Justinian, at which period we may presume the Parthenon was adapted for Christian worship and the previous solid columns removed. The size agrees very well with the traces left on the pavement of the later columns, viz. about 2.1 in diameter. The workmanship of this entablature seems to be all of one period, but that is not the case with several other marble beams of corresponding length, six varieties of which are engraved, which exhibit on their faces and at one end the fine finish of classical times, whilst the joint at the other is by comparison very rough. It is evident that one end has been worked afresh for the purpose of adapting

¹ These doors were first described by Bötticher, *Untersuchungen*, p. 166. Herr Bötticher, however, did not notice that the valves of the doors opened different ways.

them to a shorter bearing. A comparison of the cramp marks at the two ends shows approximately how much has been cut off.

Three of the six give results as follows:—

	Present length.	Restored length.
D	8.180	8.590
E	8.175	8.615
C	8.210	8.658

Another, which is somewhat less
conclusive than the above, as
the lateral cramp marks are
wanting, gives

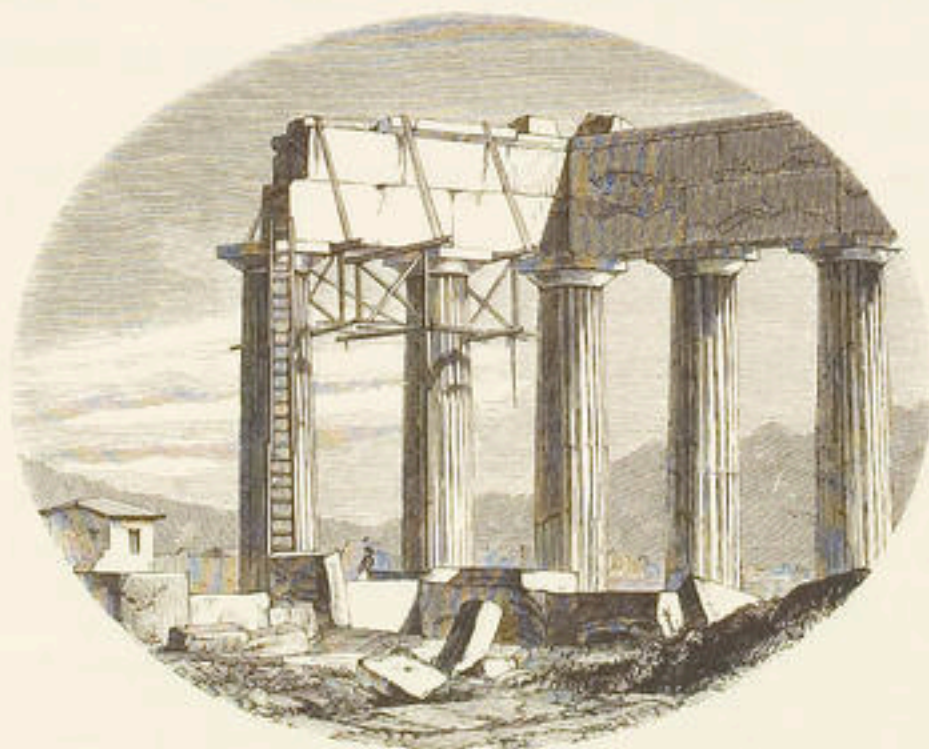
8.28	8.690
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We may safely conclude that the beams in question belonged to the upper range of the columns of the Naos, and were afterwards shortened to enable them to perform a similar function for the church which, we know from Wheeler's account, exhibited two tiers of columns, forming a kind of gallery.

It does not impair the argument that two of the beams do not conform to the same gauge. For there would be no less than six columniations at the ends and at the angles which would have special lengths not inconsistent with these two pieces.

There seems to be evidence both in the Pronaos and Posticum of the action of fire. There are numerous iron pins fastened on to the echinus of some of the capitals on the side towards the temple as well as to some other parts. These have evidently been intended as *keys* for plastering, for the purpose of making good the surface where injured by fire. Bötticher indeed,¹ refers them to the original *grillage* by which these parts of the temple were fenced in, but the positions occupied by many of these pins on the calcined beams, etc., adjacent to the columns, show that they were merely inserted for the sake of subsequent repairs.

¹ *Untersuchungen*, p. 148.



CHAPTER III

SECTION I

ON THE DISCOVERY OF THE CURVATURE OF THE HORIZONTAL LINES OF THE PARTHENON AND SOME OTHER GREEK TEMPLES

ONE of the principal objects of this work is the investigation of the various delicate curves, which form the principal architectural lines of certain of the Greek buildings of the best period; which lines, in ordinary architecture, are (or are intended to be) straight. In the course of our inquiries we shall perhaps be enabled in some degree to extend and correct our views of the geometry and mathematics of the ancients, by establishing the nature of the curves employed; but what more particularly concerns us is to determine if possible how far they affect, either constructively or æsthetically, the architecture to which they are applied.

The most important curves in point of extent are those which form the horizontal lines of the buildings where they occur; such as the edges of the steps and the lines of the entablature, which are usually understood to be straight level lines, but in the steps of the Parthenon and some other of the best examples of Greek Doric, are convex curves, lying in vertical planes; the lines of the entablature being also curves nearly parallel to the steps, and in vertical planes.¹ But it may first be desirable to state briefly the manner in which the existence of the curvature in the Parthenon was brought to light. I shall then describe the nature of the curvature itself, reserving, to be described in Chap. XV., the reasons which probably led to its adoption.

The earliest mention of the subject is in Vitruvius in his chapter *De Substructionibus*, etc., lib. iii. 3.²

"Stylobatam ita oportet exæquari, uti habeat per medium adjectionem per scamillos impares. Si enim ad libellam dirigetur, alveolatus oculo videbitur. Hoc autem uti scamilli ad id convenientes fiant, item in extremo libro forma et demonstratio erit descripta."

¹ Mr. John Pennethorne, to whom the discovery of these curves is due, seems to have fallen into an error on this point. It is stated on his authority (Leake, p. 573) that "while the step is a simple vertical curve, the lines of the architrave are curves of double curvature: this character of curve being still more marked in the cornice." These curves as they stand, at least in the fronts of the Parthenon, have certainly a curvature in a horizontal as well as in a vertical plane. The architrave of the east front is bowed inwards about .1, and the line of the under side of the corona of the cornice about twice that quantity, and in a comparatively regular manner, more resembling however a plane curve inclined to the horizon at about an angle of 45° than a line of double curvature. The effect of this curve upon the plumbs of the abaci may be seen in Plates VII. and VIII. During my examination of the temple I met with many proofs that the curve, so far as its horizontal direction (*i.e.* the curvature on plan) is concerned, has resulted from accident, and formed no part of the original design. Of these proofs the following are the most satisfactory. The great stones forming the cornice at the angles of the temple, which are upwards of 8 feet long on each face (see Plate XVII.), are rectangular on the plan; whereas, if a horizontal curve in the cornice had been designed, there would have been a sensible difference from the right angle in so considerable a length. Again, the openings and cracks in the architrave of the East Front, given in Plate VI. (leaving out of the question the ragged cracks,

which occur upon and close to the abaci of the angle columns, and which are sufficiently explained by the twisted position of the southern capital, and the sliding of the broken portion of the architrave upon the northern abacus), are on the whole considerably greater in amount on the internal than they are on the external face of the architrave, thus showing that the curve has resulted from accidental movements. Again, there are several horizontal shifts in the drums of the angle columns, whereby the original inclination of .228 (see Chap. V.) has been diminished by .1, nearly the whole amount of the sagitta of the horizontal curve in the architrave of which we are speaking. The nature of these movements may be thus explained: The various concussions which the building has undergone, having loosened the joints of the architraves and entablatures on the flanks, caused them to spread outwards, moving the capitals of the angle columns a little towards the east, while the centre of the front was comparatively little disturbed. Similar indications occur in the west front, and in the portico of the Posticum (inner order), where the angle columns have been also slightly pushed forward by the spreading of the upper part of the cella wall.

² In the quotation from Vitruvius I follow the old arrangement of chapters, as best known: at the same time being fully aware of the great improvements introduced into the text in later editions, and especially that of Schneider, 8vo, Leipzig, 1807.

Which Mr. Wilkins thus translates, freely but correctly—¹

"The stylobate ought not to be constructed upon the horizontal level, but should rise gradually from the ends towards the centre, so as to have there a small addition. The inconvenience which might arise from a stylobate thus constructed may be obviated by means of unequal scamilli. If the line of the stylobate were perfectly horizontal, it would appear like the bed of a channel."

And further on in the same chapter—

"Capitulis perfectis, deinde in summis columnarum scapis non ad libellam sed ad æqualem modulum collocatis, uti quæ adjectio in stylobatis facta fuerit, in superioribus membris respondeat symmetria epistylorum."

Which is thus translated by Wilkins—

"In placing the capitals upon the shafts of the columns, they are not to be arranged so that the abaci may be in the same horizontal level, but must follow the direction of the upper members of the Epistylum, which will deviate from the straight line drawn from the extreme points, in proportion to the addition given in the centre of the stylobate."²

It is impossible that any words can be more explicit than those of Vitruvius, and the perplexing words *scamilli impares*, which have cost commentators whole volumes, have now been explained, at least in Doric examples, by the differences of the measurements both in the upper and in the lower drums of the columns affected by the curvature.

There is a long interval between the time of Vitruvius and that of the first notice of the fact upon the spot, and it was not until the year 1837, when much of the rubbish which encumbered the stylobate of the Parthenon had been removed by the operations carried on by the Greek government, that the curvature was discovered by the late Mr. John Pennethorne, an English architect then at Athens. This gentleman mentioned the fact to some of his friends;³ and a few years afterwards enlarged upon the subject in a pamphlet printed for private circulation. In the meantime, however, the curves were noticed by Messrs. Hofer and Schaubert, German architects, and communicated by them to the *Wiener Bauzeitung* in 1838. In a more recent and beautifully illustrated work which Mr. Pennethorne published, he enters very fully into these peculiarities as well as the other refinements of Greek architecture.⁴

Now, however strange it may seem that no one had attempted to collate on the spot the passages of Vitruvius quoted above with the architecture of the Parthenon, it is by no means so unaccountable that the curves were not sooner discovered from an inspection of the building itself; for the amount of the curvature is so exquisitely managed that it is not perceptible to a spectator standing opposite to the front; at least not until the eye has been educated by considerable study founded on knowledge of the fact. It may indeed easily be remarked by any one who places his eye in such a position as to look along the lines of the step or entablature, from end to end, which in architectural language is called *boning*. But prior to the excavations above-mentioned, the steps were probably so much encumbered as to have prevented any one looking along their whole length; and previous to the discovery of the curvature, probably but few architects had examined the entablature with scaffolding or ladders. Such observations as could be made from the top of the building, which was easily accessible, or from fragments which they found upon the ground (from none of which is the curvature readily deduced), were sufficient for the purposes they had in view; nor would this curvature have been sufficiently apparent to excite their attention, even if they had ascended to the architrave or lines of the capitals in the fronts, unless it had been near the angles of the building. Again, when we consider the long interval which elapsed between the visits of Stuart and that of Professor Cockerell,⁵ by whom the entasis of the column of the Parthenon was discovered; and that it was reserved for Professor

¹ Wilkins's *Vitruvius*, p. 21. Wilkins's translation of this passage is preferable to the others in our language, on account of his clearly explaining the word "adjectio" as a rise above a straight line joining the ends of the stylobate; he fully recognises the meaning of Vitruvius, and attempts to explain the philosophy of it, by reference to the structure of the eye, and to the tendency of his author to reduce everything to the guidance of physical principles—and he adds, "this great refinement suggested by physical knowledge, does not appear to have entered into the execution of the works of the ancients."

² Mr. Wilkins argues, p. 22, note, see also Plate V. Section I.; that if the stylobate, which is generally supposed to be below the eye, requires to be made convex, the epistylia should, by parallel reasoning, be made

concave. This misapprehension sufficiently accounts for the indistinctness of his translation in the last passage quoted, in which he uses the word deviate to represent the words of Vitruvius, "respondeat (adjectioni) quæ adjectio," etc.

³ The Rev. John Hill, the American Missionary and Chaplain to the British Legation at Athens, assured me that the fact of the curvature of the Parthenon was mentioned to him by Mr. Pennethorne in the year 1837.

⁴ *The Geometry and Optics of the Ancients*, by John Pennethorne, fol. London, 1878.

⁵ The architects and agents employed by Lord Elgin no doubt had these opportunities, but they were otherwise occupied.

Donaldson to establish the Vitruvian inclination of the columns,¹ we need not be greatly surprised that this curvature in the horizontal lines was not found out until a still later period. Whether all the subtleties of construction which the Parthenon contains have yet been discovered, must be left to time and future investigators to determine. I imagine, however, that anything of this nature, yet unknown, can scarcely be important; as the meaning of Vitruvius seems to be explained by what is now brought forward, and the dimensions here produced confirm one another with great accuracy. This last could scarcely have been the case with many of those taken by the architects, who proceeded on the assumption that the principal lines of the building were straight; for the (now established) curvature of these lines must have vitiated some of their measurements.

SECTION II

ON THE 'APMONIA' OR JOINTING OF THE STONES IN GREEK ARCHITECTURE

It will be desirable, before entering further on the subjects of the curved lines, to say a few words on the nature of the jointing of the stones, premising that if I use the word bed, or course, I mean horizontal joints; if joint alone, I intend the vertical or heading joint. These, whether beds or joints, are made invariably to fit so closely that, unless where the stones have been separated by the violence of earthquakes or other concussions, it is frequently difficult to perceive them; and when discovered it is almost impossible to imagine a finer line than they show. This can hardly have been produced by other means than by the stones having been rubbed upon one another; no third surface used as a plane could have given such a degree of fine-

ness. It has been observed by Stuart² that the stones forming the steps under the columns have actually grown together, so that on breaking off parts of two stones at the joint, he found them united "as firmly as though they had never been separate."

This jointing of the stones, called by Pausanias *ἀπμονία*,³ is well exemplified in the case of the drums of the columns. The operation which I am about to describe will be readily understood by reference to the annexed woodcut.

When the stylobate and pavement had been put together, the surfaces were left in a comparatively rough state, excepting those parts destined to receive the lower drums of the columns. Here the surface was first sunk to the proper depth, accurately smoothed, and then uniformly worked lightly over with a fine-toothed chisel, in order to produce a moderate degree of roughness, for the purpose of giving, by means of the friction between the two surfaces, a sufficient hold to the superincumbent

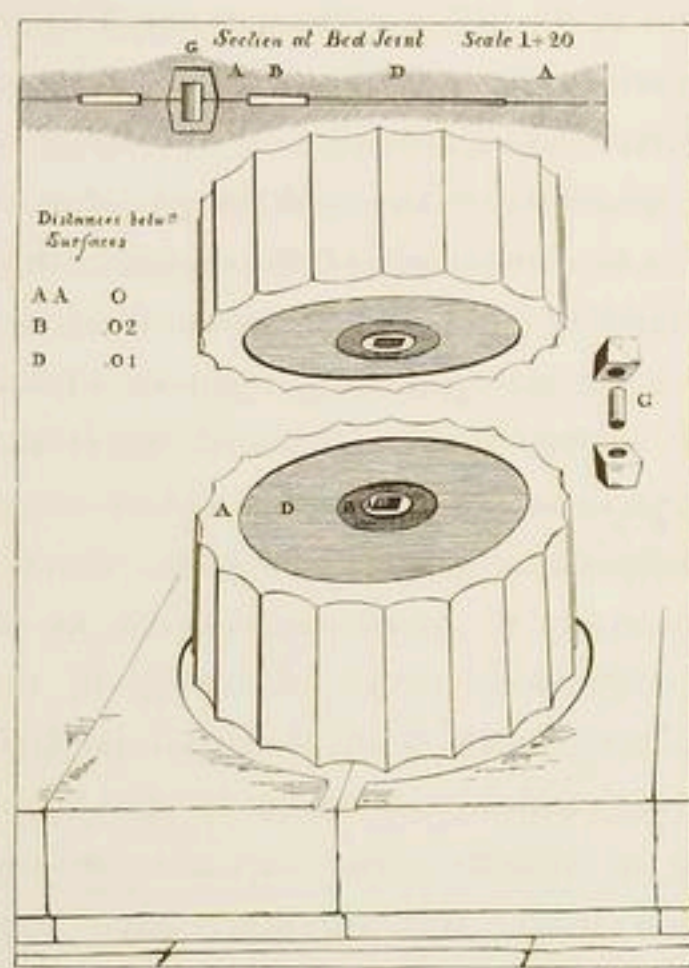


FIG. 2.

¹ 2d ed. Stuart, vol. iv. p. 11, Description of the Temple of Apollo at Bassæ. The three periods above alluded to are 1755, 1810 and 1829 circ. To show how little the eye is cognisable of a very slight curvature in a general view, the reader's attention may be directed to the west front of St. Paul's Cathedral, where in the lower, or duodecastyle portico, there exists a sort of curvature in the horizontal lines of the stylobate and entablature similar to that in the fronts of the Parthenon; not so regular indeed, but continuous, and almost identical with it in the height above a straight line joining the extremities, and in the length of the line affected by the curvature (viz. the rise is .22 in a length of 100 feet). At the same time it must be obvious in the case before us, that we are not only justified "a priori," in attributing the curve to the towers at the flanks of the portico having settled in some degree into their substratum of London clay; but a crack in the centre of the architrave shows distinctly that this has been the case. Since the above was written the steps have been renewed, and the curvature which the line taken by the bases of the columns demanded has been made more uniform.

² 2d ed. vol. ii. p. 36, and note c. Without having tested Stuart's experiment I am quite ready to admit the fact recorded, and even doubt whether he be right in limiting this adhesion of the contiguous stones to the vertical joints; as I think I have noticed indications of it in the drums of the columns (see note 4 in p. 28, in Section III. of this chapter). I am further disposed to question the explanation given by Mr. Kinnard in the note to the passage cited above, that the infiltration of water at the vertical joint is the cause of the adhesion. May not the attraction of cohesion taking place between the two surfaces in almost absolute contact, and under considerable lateral pressure, be sufficient to account for it? The joints seem much too fine to allow water to penetrate them; and the same force which sometimes causes two pieces of plate glass in contact to adhere together, is probably sufficient to induce molecular action between crystalline surfaces of Pentelic marble, worked to the highest degree of smoothness.

³ Paus. *Arcad.*, c. 41, speaking of the temple at Bassæ.

weight. The surface so sunk was defined by a circle, a little larger than the lower diameter of the column; and the roughened portion by a plan of the column, with the flutes carefully traced on the pavement. The plan served afterwards for fixing the lower drum, on which also the flutes were finished, but for a small height only.¹ This drum was probably rubbed upon the surface of the pavement prepared for it, until it accurately fitted, and was left with its flutes coinciding with the plan traced, as above-mentioned. It was then ready for the reception of the second drum. But between these two the bed is differently formed. Exactly in the middle of each frustum is a square sinking about .37 foot wide at the surface (rather less below), and .23 deep (see the representation in the previous woodcut), into which was firmly fitted a piece of wood, either flush with, or sunk a little below the surface of the drum. A cylindrical hole about .16 foot in diameter was then bored in the middle of each of these small blocks, and the two drums were then connected by a round wooden pin, accurately fitting the hollows in the two inserted blocks of wood. A sort of centre was thus formed by means of which one drum could be made to rotate upon the other.²

Around this centre (taking the case of one of the lower drums where the diameter is about 6.2 feet) we find that the surface of the drum is smooth for a diameter of about .81 foot, after which it is sunk away about .01 in a ring of .42 wide, then sunk .005 in a ring 1.5 in width, leaving a ring of about .75 of smooth work in the same plane as the surface round about the centre; so that the weight of the column was borne on the circular portion .81 in diameter about the centre, and a ring of about .75 wide at the circumference. It was no doubt found to be more easy to secure a perfectly fine bed joint by this method, than if the column had been allowed to bear over its full surface.³ The object of the wooden centre could not have been to sustain any part of the weight of the block for the purpose of turning it cylindrically as in a lathe, for which its strength would have been inadequate, but merely to keep it centrally over the drum below, while moved to and fro through a small arc.

The stones were turned round with the help of ears (*ῥα, ancones*),⁴ which were at first left on the cylindrical surfaces of the drums. The drums were probably also hoisted by ropes fastened round these projections. The greater part of the operation of forming the beds was no doubt done on the ground; but the wooden centres were left between the drums when they were fixed, partly to secure to them the exact positions in which they fitted most closely, when prepared below; and partly also to enable the operation of rubbing to be renewed should any imperfection be found in the beds at the time of fixing the drum. And until reduced by shrinkage, they would serve to prevent any lateral motion arising from accidents or natural causes. When the columns were thus completed, the ancones were worked off, and the shafts were left of a cylindrical or, more correctly, of a conical shape, until the last completion of the building; in the state described in the Erechtheum inscription, *ἀκατέξεστα, ἀράβδωτα, unsmoothed and unfluted*.⁵

The beds of the stones composing other parts of the building are somewhat similarly formed, excepting that no parts of them are sunk. The middle of the bed is roughened by lines cross-hatched and dotted, with a rim of smooth work left round the edges.

These stones seem to have had a full bearing over the whole surface; but a smooth junction only towards the edges; which seems also to have been produced by rubbing them together till the edges, at first left a little above the rest of the bed, were worn down to the general surface.

The vertical joints⁶ are formed like those of the drums of the columns, excepting that the *ἄρμός*, or

¹ See Plate XLVI., where is given an elevation of a similar drum.

² One of these pins from the Propylæa is preserved in the Museum of the Institute of British Architects. It resembles olive wood; it is, however, stated to be of the juniper cedar (Leake's *Morea*, ii. 8).

³ These sinkings would have had the advantage of allowing the dust produced in the rubbing the two blocks together, to escape readily into the hollow parts.

⁴ Instances of these are shown, Plate XLVI. and vignette at the head of Chap. I.

⁵ Besides the presence of the wooden centres, the measurements of the scamilli impares given in Plates VII. and VIII. afford direct proof of the stones having been rubbed one upon the other. Had the surfaces of the beds been smoothed by the help of a common surface, they could not have fitted in the perfect manner in which we find them, unless they were all absolute planes. But among the dimensions given of the upper drums (which as they could be measured with more certainty than the lower are preferable for the present inquiry) it may be seen that in some cases a slight difference exists between the sum of the measurements taken on

the north and south, and those taken east and west. The difference in the second column from the northern angle is considerable; but to avoid the chance of this difference (.01) being thought a clerical error, I would refer to the third from the south-east, which gives .004. This, though small, is an appreciable quantity, and inconsistent with the two surfaces being perfect planes.

⁶ Very great difficulty occurs in explaining how the vertical joints of the architrave stones could be brought to the exquisite fineness which many of them still retain. We may understand how the drums of the columns would have been rubbed together by rotation, and how others of the beds may have been formed by sliding one stone upon another: but how the vertical joints of stones upwards of 14 feet in length and of considerable depth could have been so perfectly formed is very wonderful; for they must have been too unwieldy to enable this object to be effected by rubbing them together. Modern masons sometimes produce vertical joints of considerable fineness by passing a thin saw blade between the two contiguous surfaces, already carefully prepared, and afterwards wedging the stones closely together. But some light has been thrown on this question,

rim of smooth work, prevails around the external edges only. All the rest of the surface is sunk, so that the stones did not touch at all in the middle.

From what has been said of the nature of the joints, it will be evident that many of the projecting mouldings would have been liable to injury from the pressure of the superincumbent weights, had not the surface of the bed, immediately above them, been a little sunk, so as to confine the bearing to the solid parts. Several instances of this are given in Plate XX. Hence may have originated the groove or sinking at the neck of the Doric capital (which, however, even in the earliest examples, was treated ornamentally), an adjustment which would have had great value in protecting the flutings of the lower part of the capital from being chipped whilst they were being fixed.

For the same purpose of providing for the preservation of the architectural features during the progress of the work, the greater part of the mouldings, and almost all the architectural faces, were not worked until the building was put together. This is also further to be inferred from the remains of several ancient buildings (even the Parthenon itself in some minor particulars) where portions, more or less, remain unfinished; as also from the inscription relative to the Erechtheum. Thus the method followed in building a temple was: first to construct the pavement and steps with their outer surfaces rough, as seen at Segeste and other places, providing only a narrow finished surface in the internal angles of the steps, and a plane sunk surface to receive the lower drums of the columns, where an outline was traced on the pavement to correspond with the flutes, which were executed at the foot of the column itself for a very small height. The next step was to build the columns in plain cylindrical drums, smoothing off the ancones as they were built; the capitals only (which in Doric were turned)¹ and that portion of the flutes which intervenes between the neck of the column and the echinus, being of finished work. "Capitulis perfectis in summis columnarum scapis."² After these the architraves and other parts of the entablature were built with fine beds and joints, but with their surfaces still left rough.

When the whole construction was thus completed, the finishing would naturally begin at the top. Such surfaces and mouldings as were hitherto left rough would be smoothed, polished, and in those cases where pigment was to be applied, painted. The flutes of the columns would be formed as the scaffold and workmen descended (the small portion of the fluting which had been prepared below and that already executed at the neck serving as fixed points to guide the curved line which formed the entasis of the columns;³) and the last part smoothed and polished would be the stylobate.

It is an interesting fact that examples are preserved to us in almost all these stages. In some there are remains of ancones left in the entablature and other members. In others the columns are round, with those parts only of the flutings finished which are close to the base, and those which form part of the capital.⁴ And thirdly the Propylæa at Athens, entirely finished (at least in the central part), with the exception of working off the extra surface left to protect the stylobate, etc. In the Parthenon we find the highest degree of finish, with the exception of a few trifling particulars, one of which is mentioned below in note 3. In this case, as in the few others similar to it, the omission may perhaps have been caused by the last finishings of the work having been effected hastily in consequence of the threatened approach of the Peloponnesian war. As far as we can ascertain, the finishings of the Theseum were thoroughly brought to perfection.

A conclusion which I am desirous to draw from the original closeness of the joints and beds, coupled with the strength of the material, and its almost entire exemption from injuries of weather, is, that by

by the discovery of an inscription reciting the method to be used in preparing the joints of the stones for a temple of Jupiter at Lebadea. Vermilion and olive oil were to be applied in some unexplained manner, and a stone canon, or rule, was to be used. (See an article which was contributed by Mr. W. W. Lloyd to the *Builder*, Apr. 28, 1877.) In producing, by whatever means, that perfection of joint which exists, it is likely that some stones would be more *wasted* than others, and thus may have arisen some slight irregularities produced by the differences in the length of the stones; such for instance as are seen over the abaci of the angle columns (see Plate VI.) where the architrave in one case sets back .454 foot and in the other case .412.

¹ See a note at the beginning of Chap. VII.

² Vitruv., III. 3.

³ On the fourth column from the north-east angle in the east front of the Parthenon, a little below the capital, a small part of the fluting on the inside towards the Pronaos is left unfinished for about the size of a man's hand. The line of the entasis along the fillet of the flute is accurately traced

through this rough portion. There is the appearance of an original flaw in the marble, and the case may probably have been, that in consequence of this flaw the workmen may have left it in this state for the moment, and that it was afterwards overlooked; for the work might have been made much more regular and smooth than it is without weakening the parts about the flaw.

⁴ Of the temples, etc., whose columns remain in an unfinished state, those best known by published examples are, that of Apollo at Delos described by Stuart; that of Nemesis at Rhamnus; of Ceres at Eleusis; the Stoa at Thoricus (see for these the *Uncollected Antiquities of Attica*), and the Temple of Segeste and others in Sicily; see the publications of Professor Wilkins and the Duca di Serra di Falco. It cannot be doubted that all these temples were intended to be finished, but owing to some interruption arising during the progress of the work, they were left in the state in which we see them. But whatever the motive, we must not conclude from such examples that we are right in copying (as has sometimes been done) buildings in this defective state.

a careful measurement of such shifts and cracks as have taken place, either from earthquakes or the agency of man, we may arrive at a knowledge of the original position and direction of the lines of such a building as the Parthenon, with almost as great certainty as if no earthquakes or explosions had shaken or shattered it.

SECTION III

DESCRIPTION OF THE CURVATURE OF THE HORIZONTAL LINES IN THE PARTHENON, TOGETHER WITH SOME REMARKS ON THE SAME SUBJECT IN OTHER GREEK TEMPLES

PLATES X. XI. XII. XIII.

OF all the examples of curvature in the horizontal lines of Greek structures, which I have examined by measurement, the sub-basement of the Temple of Jupiter Olympius at Athens¹ has the least amount of curvature in proportion to its length. The earlier Parthenon (mentioned in the description of Plate IX.), and the Temple of Theseus, have nearly the same amount of relative curvature, while the greatest amount is found in the stylobate of the new or Hecatompedon Parthenon, and in the Propylæa. In the latter, however, the curve only occurs in the entablature, the line of the steps being straight and level. The measurements are given in the two first columns of the following table; and if the length of the curved lines in the above-mentioned cases be all either increased or diminished, as the case may require, to a uniform length of 100 feet (the rise in the centre of the line always preserving its proportion to the length), the third column will give the relative amount of rise.

Buildings.	Actual length of the front or flank measured.	Actual rise above a straight line joining the extremities.	Proportional rise corresponding to a length of 100 feet.
1. Jupiter Olympius—			
Flank	354.2	.25 nearly	.07
2. Sub-basement of the Parthenon—			
Front	104.2	.150	.145
Flank	221.	.233	.105
3. Theseum—			
Front	45.	.063	.140
Flank	104.2	.101	.097
4. Parthenon—			
Front	101.3	.228 = Flank $\times \frac{1}{1000}$	.225 = $\frac{3}{2} \cdot 145$ } very
Flank	228.1	.355	.156 = $\frac{3}{2} \cdot 105$ } nearly.
Entablature from Eastern front . .	100.2	.171 = $\frac{3}{4} \cdot 228$	.171
Do. on flanks, restored	227.	.307	.135
5. Propylæa—			
Entablature from Eastern portico .	68.1	.119	.175

It will be seen from the above table that the relative curvature of the Theseum is about the same as that of the earlier Parthenon; while in the Periclean temple it is greater by one half. The effect of the curvature in the case of the Temple of Theseus may have shown that an increase of curvature would be attended with advantage. There was no model immediately before the eyes of the builders of the Theseum, for the earlier Parthenon was then in ruins. It would, however, seem to be in accordance with the practice of the Greeks, that in consequence of its greater size the Parthenon should have had a greater relative curvature than the Theseum. This is well illustrated in the case of the entasis of the Propylæa. It will be seen by reference to the tables in Chap. V. that the small order has only $\frac{1}{3}$ of the relative entasis of the large order. In very small structures there does not appear to have been any departure from ordinary rectilinear construction. In support of this the Temple of Nike Apteros may be cited, in which, although of the very best period of Greek art, the columns have no entasis whatever.

¹ On the subject of this temple see Chap. XII.

I have also observed curvature to a very considerable extent both in the fronts and flanks of the temple at Nemea¹ and of that of Segeste in Sicily. It occurs also, but only in the fronts, of the Temple of Neptune at Pæstum, though to what extent I did not determine by levelling. The average of the measurements of the scamilli impares gives a difference of .045 east and west, and there seems to be a rise of about .12 in the length of the front, which is about 79 feet.

Besides the above, I have examined the stylobates of the Temples of Nemesis at Rhamnus, and of Jupiter Panhellenius at Ægina, that of Apollo Epicurius at Bassæ near Phigaleia, and the remains of the temple at Corinth, with a view of ascertaining the existence or non-existence of curvature in the horizontal lines. The result is, that I am satisfied that although the columns both of the temple at Rhamnus and that at Ægina incline inwards (the latter having a very beautiful entasis),² in neither of them was there any curvature in the stylobate. The temple at Bassæ has been so much disturbed by earthquakes and corroded by time in that wintry situation,³ that the only way safely to test the curvature was by the measurements of the scamilli impares. These measurements, both from the lower and upper drums, tend to demonstrate that there was neither any inclination of the columns, nor curvature of the pavement or entablature. Moreover, it seemed very doubtful whether the columns have any entasis;⁴ so that, although this temple was undoubtedly a work of the very best period, we may suppose that, owing to its comparatively unfrequented situation, it was not thought worth while to go to the great extra expense which these curved lines would have entailed. The actual construction was of the very best quality, and particularly praised on this account by Pausanias.⁵ The stylobate of the temple at Corinth shows undoubted traces of curvature, but on the front only. The increment of curvature is small, amounting only to .07 in a length of about 70 feet. At Sunium there is decided curvature on the flanks. The fronts are ruined.

In the instances given above, I have confined myself to buildings which I have myself observed. There can be little doubt but that other examples of curved lines may be found. That all these cases of curvature can have arisen from accident or subsidence is utterly impossible. In that case the lines would be broken and uneven, instead of the beautifully regular curves which we generally find; still less would it be found in every case of curvature in the front of a temple, that the very part which is raised most above the level, namely the centre of the front, is that where the greatest weight (that of the pediment) presses upon the stylobate;⁶ which reasons, coupled with the provision of the scamilli impares, leave no doubt upon the subject.

¹ Some measurements of the Nemea temple are given in *The Antiquities of Ionia*, Part II., and in the *Expédition Scientifique de Morée*, still it may not be out of place for me to give a few notes of an examination of its ruins; which, however, owing to an unlucky interview with some Arcadian κλέφται on Mount Cyllene, by which I lost some of my measuring instruments, was not conducted under the most favourable circumstances. From the best observations in my power to take, it appeared to me that the curvature of this temple was more considerable, especially on the flank, than that of the Parthenon. This is what might be expected in an example, which, though undoubtedly of a good period, shows some indications of the decline of art; for a system which had been gradually developed, as was the case with the increment of curvature, would be liable to be carried further and further, until from over exaggeration it fell into disrepute. It is owing to an analogous tendency in art to run from one extreme to another that the overwhelming echinus of the archaic Doric capital became less and less, till it was reduced to its last meagre and insipid form in the gate of the Agora at Athens. In the columns of the Temple of Nemea, this last-mentioned tendency is already exhibited to some extent. The lower diameter of the columns of the peristyle is 5.15 feet, the upper 4.36. The width of the abacus 5.81 = $\frac{4}{3} \times 4.36$. The thickness of the abacus is .8. To compare these dimensions with those of earlier examples; in the Temple of Theseus the projection of the abacus over the upper diameter of the column is $\frac{1}{10} \times$ abacus. In the east front of the Parthenon $\frac{1}{10} \times$; at Nemea $\frac{1}{10} \times$. Another sign of a later period in this temple is found in the diminution of the columns. This in the Theseum is $\frac{1}{10} \times$ lower diameter; in the Parthenon $\frac{1}{10} \times$; at Nemea $\frac{1}{10} \times$. The thickness of the abacus at Nemea is $\frac{1}{10} \times$ of its breadth; in the Parthenon $\frac{1}{10} \times$; Theseum $\frac{1}{10} \times$. In other respects there are no signs of decline in the Temple of Nemea. The columns are slenderer than those of the Parthenon, but the entasis and the flutes are very similar; and they are inclined from the perpendicular in the same manner. The measurements of one of the scamilli impares from the east front is 2.39 feet east, and 2.35 west.

The height of the face of the architrave is 3.06 feet, the band .27 more. This is less in proportion than in the Parthenon. The frieze over the inner order of the Pronaos had triglyphs. The height of the columns of

the peristyle (reduced from the measurements given in the *Expédition Scientifique*) is 34 feet; those of the Pronaos 30.75; the diameter of the latter being 4.59.

It will be seen by the tailpiece at the end of this chapter, which is a view of the temple from the south, that three columns only are standing, viz. one of those of the east front and two of the Pronaos. A great mass of ruin remains on the spot, indeed it seems that very little has been removed. The exact nature of the curvature and other interesting points might probably be recovered by a diligent examination aided by slight excavations.

² Both the entasis and inclination of these monolith columns of the temple of Ægina are given by Mr. Jenkyns in the second edition of Stuart, vol. iv., in the fifth plate of his contribution.

³ There was not the slightest sign of verdure on the trees on Mount Cotyium, April 26th, and owing to the inclemency of the weather I could only effect a small part of what I wished at the temple, although I had devoted several days to its examination. The state of this building well illustrates the effect produced on the horizontal and vertical lines by earthquakes. The lines of the step and entablature are wavy, occasionally up and down. Some of the columns lean inwards, others outwards, with entire want of system, very different from the symmetrical curves and regular inclinations of the columns found to so remarkable a degree in the Theseum and Parthenon, etc.

⁴ This is in accordance with Mr. Donaldson's remark on the same subject, *vide* Stuart, second edition, vol. iv. p. 11.

⁵ Paus. *Arad.*, c. 41.

⁶ Did it not seem quite unnecessary to carry this argument further, a direct proof could be obtained from the measurement of the cracks in the architrave stones (given in Plates VII. and VIII.), a conclusive test (especially in a Greek building of the best time) in discriminating between a real or accidental increment of curvature. Thus, an apparent curvature of a tolerably regular description in the portico of the northern wing of the Propylea, where the architrave rises about .08 above a straight line joining its extremities, was by this test shown to have resulted from a slight subsidence in the western extremity of the foundation, where the stylobate is elevated considerably above the rock.

The Plates X. XI. XII. are devoted to the illustration of the curvature of the principal horizontal lines in the Parthenon.

In Plate X., which is confined to the east front, a level line LL is drawn through the north angle of the step falling .006 below that at the south.

Measured upwards from this line, at the centre of each column, *C, C, etc.*, are given the ordinates to the curved line.

These points having been determined, the curve was filled out by the help of the directions of the plane of the base of each column, obtained separately from the levels of the points of bearing of the north, south, and west flutes on the pavement.

The levels of the original surface could only be obtained with certainty close to the columns, as the stylobate has invariably been more or less worn away in the intervals. The extreme points of the curve are obtained by a calculation derived from the plane of the base of the angle columns.

Above the shaded line is given the levelling of the underside of the architrave both on its east and west faces.

Above this is given the rise above a level line of the underside of the architrave band of the east front, Plate X., taken for the most part¹ at the extremities of each of the guttæ tablets under the triglyphs,² signified by the letters *t* on the plate.

Under the shaded line are given measurements with a micrometer of the small openings which have taken place in the joints of the step under the columns. I was led to examine these openings by an impression that they might have modified the curved lines, but they do not appear to have affected them sensibly.³

This plate, as well as the two following, give the true nature of the curvature, but in an exaggerated form; such as it would appear viewed in geometrical perspective, the point of sight being taken very nearly in the line of the steps or architrave. In the Plates X. and XI. the horizontal distances are diminished 100 times, and the vertical dimensions are half the real size. In Plate XII. the horizontal are diminished 200 times and the vertical lines four times. So that in all these plates the curves are exaggerated in the same proportion, viz. the heights are 50 times greater than they should be if the drawings had been made accurately to scale.

The trifling irregularity of curvature which is shown in Plate X., in the step under the second and third columns from the south angle, appears to be owing to a slight settlement. If this be restored with the help of the indications afforded by those parts affected by it,⁴ the whole curve assumes a very exact and

¹ At some of the triglyphs no measurements are given. At those points either the original surface could not be identified, or else the position was too near the levelling instrument to allow of its being brought distinctly into focus.

² These lines were all measured independently, and thoroughly confirm each other; they were taken with a telescope level, the collimation being on every occasion either previously correctly adjusted or its errors allowed for. The steps of the north, west, and east sides, and the east and west architraves, were taken several times over, and their small differences have been compared and averaged until the result here given may be considered quite correct. The others also may be confidently appealed to as substantially correct, their greatest amount of error probably not in any case exceeding .004. The instrument was capable of distinctly marking a difference of level of .01 at a distance of 228 feet, and very few of the measurements of which the results are given in any of the plates in this work were taken at distances exceeding 50 feet.

³ The joint is always close, sometimes invisible, at the top, and usually perfectly close for more than half the way down the step. Then these slight openings begin to be perceptible. They do not occur at all in the stylobate of the northern half of the eastern front, which rests directly on the rock, but only in that of the southern half and in the west front, where the distance above the rock foundation is considerable. Hence it seems likely that these openings were produced by the concussions which the building has received from earthquakes, of which there are also other indications. These shocks probably opened slightly the joints, and this would take place to the greater extent the further they were removed from the rock. Afterwards, the great weight of the columns, acting during a long period of time upon the narrow rim of smooth marble which forms the vertical joints, pressed together the upper portions of the marble, and brought them into the exact contact which has been described in a former page. If this be the true explanation, we must deduct .006 from 101.33 (see note in Chap. II.), and .009 from 101.35, to obtain the original breadth of the east and west fronts respectively; for such openings only as show at the top of the step have hitherto been taken into account.

⁴ By reference to Plate VIII. we may see that the inclination westwards of the former of the two columns mentioned above, which (as will be shown in Chap. V.) ought to be .228, is only .175. This has arisen from the column having at some period been pushed forward; and this we may with little doubt attribute to the spreading of the upper part of the south wall of the cella, with which it was connected by means of a marble beam, until the latter was thrown down by the explosion in 1687. In note 1 at the beginning of the chapter, I have had occasion to call attention to other results of a similar spreading in the joints of the upper parts of the building; and it is scarcely necessary to observe that it is almost an invariable attendant on decay. This column, however (in consequence, as it seems to me, of an absolute adhesion among the drums), has moved forwards as though it had been a monolith, involving in its motion that portion of the stylobate which was underneath it, while a vertical crack, in some places .007 wide, runs nearly from the top to the bottom of the shaft, in a direction about north and south, and testifies that it was acted upon with quite as great a force as that which has produced considerable horizontal shifts among the component drums of other columns. The amount of depression in the edge of the upper step, which is due to this movement of .053 in the height of the column, is about .01; and this is exactly confirmed by a greater than average departure from the level in the plane of the base of the column. The two architrave stones also, which meet over this column, instead of exhibiting, like the others, an upward curvature, show an actual depression of .009 from a straight line joining the ends of the architrave stones; and the excess of the lower over the upper measurement of the crack in the architrave to the right hand, leads us to infer a sinking of .013. On these grounds, therefore, I think we need not hesitate to restore the original measurement by increasing the ordinate to the curve of the step under this column from .109 to .119. Similar reasons justify an increase of that under the contiguous column (viz. the third column from the south) from .178 to .181.

I was led to examine the above column (the second from the south) thus minutely, when taking measurements to obtain the entasis. The surface

symmetrical appearance. A circle drawn so as to pass as near as possible to all the measured points, taking them in their actual positions, would be subject to an error of .0065 foot. If the curve be corrected as suggested in the note, and as shown by the dotted line, the error would be diminished to .004, which is less than the height of the short letters of the type used in the notes of this work; for the ordinates, measured at the centres of the columns, become

.033, .119, .181, .214, .218, .184, .120, .030,
while .030, .116, .184, .218, .218, .184, .116, .030,

are those of the circle of nearest approximation, in which the difference amounts to .004. Had we only considered the northern half, where the foundation is the most solid, the same circle might have been drawn so as to have its ordinates

.220, .186, .118, .032,

which only differs from the measurements by .002.

From this correspondence we may feel satisfied of the extreme regularity of the curvature of the eastern stylobate. That of the architrave also is an uniform curve, not, indeed, so perfectly regular as the step, yet far too accurate to have been effected without much care and management.

Some of the adaptations necessary to ensure at once the perfection of the joints of the columns and the regularity of the curve of the architrave are exhibited in Plate VI. It will be there seen that almost all the measurements of the thickness of the abacus are unequal, there being a difference of .03 between the extreme dimensions. In the operation of rubbing together the drums, some of the columns would naturally be more wasted than others; and though some amount of compensation seems to have been made in the upper scamilli, it is probable that such compensation chiefly had reference to the proper inclination of the capitals, and it would have been exceedingly difficult to make the lengths of the shafts of the columns so accurate as to preserve the curve required in the architrave without a second adjustment. At any rate, this was not attempted, and a curve passing through the necks of the columns would show a comparatively irregular line, which irregularity, though it is not perceptible in its intermittent form, would have produced a bad effect in the continuous line of the architrave. Accordingly, any small amount of irregularity which might arise in the formation of the columns was provided for by leaving a certain extra thickness in the abacus, which might be left or cut away as was required, *uti in superioribus membris respondeat (symmetria epistylorum)*.¹ The architrave, composed as it is, of seven of the straight sides of a large polygon, would probably be most easily set out by the method suggested in a diagram, Fig. 1 at the bottom of Plate X., in which AB is supposed to be a rule or straight edge, about equal to two columniations. It touches the summits of two of the columns, and determines the small quantity CD (= .029 in the Parthenon), by which the third column should fall away from the line joining the two first, in order to obtain the requisite curvature. We thus obtain the external angle of the polygon, in which the architraves ought to lie, supposing the curve to be an approximation to a circle, and which it seems to be. This operation, if conducted with sufficient care, would ensure quite as much accuracy as is found in the architrave. If, however, the method were to be applied to the stylobate (which is composed, not as the architrave of seven only, but of fifteen pieces), owing to the multiplicity of small measurements which it would involve, we should probably not obtain so accurate a result as the existing curvature presents to us. It appears not unlikely that the arc of a parabola² may have been used for this purpose, a figure with which the builders were well acquainted, and which, in the space of a man's hand, would give full-sized ordinates, which would serve as offsets from a straight line to form the required circular arc, with the utmost facility—and in so small an arc with perfect accuracy (see diagram Plate X. Fig. 2). Let the curve PAP', be a parabola constructed with any axis whatever, that shall form the curve of a convenient size, let AX be the axis of the curve. Cut off AM = .228, which I assume to be the intended increment of curvature in the centre, and draw the chord QR through M perpendicular to AX. Now let PP' represent

along the edges of the flutes being well preserved, the colour uniform, and the horizontal shifts so minute as to be imperceptible except on close examination, the curve has a more regular and beautiful appearance than in any of the other columns. I was thence led to expect a complete specimen of the entasis, without being obliged to deduce it by an elimination of the horizontal shifts by means of two measurements in each drum (see Plate XIV., and Chap. V.), as in some other instances. I found, however, a sensible

difference from the curvature which I had obtained in previous measurements. And this difference appeared wholly irreconcilable, until I perceived that it was entirely due to the vertical crack above mentioned, which had affected the real curvature of the entasis, without betraying itself as the horizontal shifts had done.

¹ Vit., Lib. III. 3.

² See Plate XLVII. Fig. 3, and Appendix, Arts. 4, 5.

the length of the front of the building, and divide it in c, c , etc., proportionally to the positions of the centres of the columns, or other parts of the front where it is desired to obtain offsets from the straight line. Then draw perpendiculars cc , cc , etc., to meet the parabola, and the length of these lines will be those required to form a practically correct circular arc:¹ the only conditions being that the distance AM shall equal the intended adjection, or increment of curvature, as I have called it, and that the arc (as here) shall be very small.

Plate XI. is devoted to the curvature of the west front. The tinted line denotes the upper step of the stylobate, and the dimensions are given as before at the centres of each column.² The level line LL to which they are referred passes through the north-west angle of the step. It will be observed that the curvature at first starting agrees almost exactly with that at the east end, but beyond the first or northernmost columniation the curve is irregular, and the south-west angle falls considerably above the north-west. This irregularity, to explain which, a recondite adjustment for the sake of perspective has been suggested, appears to be satisfactorily accounted for in the following manner: in Chap. II. p. 18, it has been shown that the basement of the earlier Temple of Minerva, which alone seems to have escaped the devastations of the Persians under Mardonius (see *Leake's Athens*, p. 311), had been lengthened out to the north to form the sub-basement of the new or Hecatompædon Parthenon. I have given in a dotted line at the bottom of the plate the levels of the course of rusticated work belonging to the older structure. The extension of the sub-basement was about 13.30 feet.

It will be seen that while the points A and B (that is, as far as the original building extends) are very nearly level, yet if this curved line, or rather a course parallel to it (for the actual course is not continued, see Plate IX.), be produced northwards to the left hand of the plate, it falls below the level of the curve at the point A . Moreover, the south-west angle of the upper step of the present Parthenon is placed about 10 feet to the left of B , and consequently higher up the curve.³

On both these accounts the steps of the present building would rise to a higher level towards the south than to the north; and unless the courses which intervene between the rusticated course, of which I have been speaking, and the principal steps were made to taper sufficiently towards the south, the difference of level so produced would remain.

The original difference of level from both causes is about .10. The alterations which have been made in the courses between the rusticated course and the great marble steps of the stylobate, are first, the thinning off a first course of Piræic stone from .96 in the middle to about .91 at the extremities, for the purpose of giving a greater amount of curvature to the new temple than existed in the old;⁴ and secondly, the thin marble course or plinth which carries the three great steps appears to have been reduced from .974 northwards, to .913 southwards, for the purpose of remedying to some extent the difference of level; while the main steps of the stylobate are equal throughout.⁵ Thus, though the difference of level is partially remedied, some still remains. And thus it appears that in constructing the three great steps (though on the east front, which was built on an entirely new foundation, the curvature must have been adjusted with religious care) they were contented with following and making use as much as possible of the lines of the west front of the old building. This will account for the somewhat broken appearance which the curve exhibits in the exaggerated form in which it is presented in the plate, but which is scarcely (if at all) perceptible in the actual building. The maximum difference between it and a circular arc, is .008 above and below the line. It may be observed, however, that the architrave, where there were no old lines to be made use of, is formed into a curve even more regular than that of the architrave at the east front.⁶

In the architrave, the interior edge or bottom of the eastern face is given in the dark line, and the measurements are taken at the points of the bearing of the architrave on the abaci of the columns.⁷ The

¹ This arises from two causes:—

I. Because all parabolas are similar figures.

II. Because the arc which forms the curve is very small, about $0^{\circ} 40'$, and, therefore, in its length there is no appreciable difference between a parabola and the circle which approaches the nearest to it, called the osculating circle. (See Appendix, Art. 7.)

From I. the ordinates obtained from the small parabola give exact ordinates for a large parabola; and from II. the large parabola practically coincides with the required circle.

² Except that of the south-west angle where the steps being broken under the centre of the column, the measurement is given as near as it could be obtained.

³ The centre of the west front of the new temple is set 8.6 feet farther north than that of the sub-basement of the old temple.

⁴ See table at the beginning of the section.

⁵ The differences of height in the steps throughout the building are inconsiderable.

⁶ Whether there could be any other object in keeping the southern angle above the level of the northern, is again considered in the following page.

⁷ The instrument was fixed under the architrave of the two angle inter-columniations and independently of the scaffolding which I used. The points given are those where the surface could best be depended upon. Where no measurement is given, either the point was too near the instrument or for some other reason it could not be distinctly seen.

western or external edge, which towards the southern parts of the front has been much shattered by cannon shot, is given in the dotted line.

The upper half of Plate XII. gives measurements downwards from a level line LL to the upper step of the north flank of the Parthenon; on which side the curve has been remarkably well preserved, owing no doubt chiefly to its uniformly solid foundation upon the rock with scarcely any intervening courses. The regularity of the curvature even in this exaggerated form cannot fail to be noticed. It is perhaps more striking than even the eastern step, although no part of this flank comes quite so near to a regular curve as the northern half of that front. Yet a circle in the actual building, or what amounts to the same thing, a parabola in this reduced figure,¹ may be drawn so as to coincide with all the measured parts of this curve, subject to a maximum error of .006; excepting in the cases of the sixth and seventh columns from the north-east angle, where the steps have evidently been somewhat injured by the falling of the masses of the superstructure upon it in the time of the explosion. Even admitting these points without correction, the error would only amount to .01 in a length of 228 feet. The levels of the steps are given at the east, west, and north flutes of the columns. Above these are drawn the two portions of the curve of the entablature which remain on this side, where such measurements as could be taken of the architrave at the abaci of the columns are referred to level lines touching the bottom of the architrave at the east and west extremities of the flank. These two lines are connected with the step by the heights of the angle columns which are given, taken opposite their central flutes.

We find that the height of the centre of the stylobate above a straight line, joining its extremities is .353;² this has very nearly the ratio of 3:2 with the increment of curvature in the fronts; for $\frac{3}{2} \times .228 = .342$.

In the lower half of the plate is given the stylobate of the south side. The difference in curvature between this and that of the north side is so exceedingly small that we may readily believe that the increment which here is .366 was intended to be the same quantity in both flanks. The existing differences are quite accounted for by the greater liability of the south side to disturbances, owing to the height of its stylobate above the rock.³

It will be observed that there is a very considerable difference of level, amounting to .158, between the eastern and western extremities of the step. Now this difference must have been made when the building was erected, or produced subsequently by settlement, or some movement by subsidence or upheaval which may have affected the whole rock.

That any settlement can have taken place is disproved, not only by the nature of the work, but also by observing that while at the north-east the bottom step of the stylobate is founded directly on the rock, while the south-west angle rests on at least 20 feet of artificial foundation, yet the latter is nevertheless the higher by .16 foot.

Secondly, there are no signs to be gathered from other buildings on the Acropolis of any movement of the whole rock⁴ which can have altered the levels of the Parthenon.

Thirdly, we may next ask whether the difference, which must be as old as the building itself, can have arisen from carelessness or want of sufficiently accurate instruments? The idea of carelessness is altogether inapplicable to Greek works, and we cannot doubt that the builders were well aware how the different angles of the steps would arrange themselves with reference to some given plane, and, so far as the question lies with the instruments employed, a water-level,⁵ such as that described with much

¹ The geometrical result of altering very greatly the horizontal dimensions of the arc of a circle, while the verticals are only slightly diminished, as in the case of the plate before us, is to produce an exceedingly elongated ellipse, which in so small an arc is perfectly represented by a parabola; this is the figure I have here used, because it is easier to perform calculations upon than either the ellipse or circle; and for the same reason I proposed the parabola in my Letter from Athens, published by the Society of Dilettanti in 1847.

As my meaning on this point has been misunderstood, I may here explain that I did not then intend to say that the parabola approximated more nearly to the actual curvature of the steps than a circle (for they are practically identical in so small an arc); but as a small parabola coincided with the exaggerated drawing, and a larger one with the actual curve, it seemed sufficient in the short limits of a letter to name only one curve.

² To obtain this curve with precision, levels were taken from twenty-five different points, *i.e.* from the two angles, the centre, every four columns

together, and every pair of columns separately, the results being put together and the small variations averaged.

³ The depth of the courses of soft limestone which form the substructure has not been reached at 30 feet below the marble steps, and an expansion of $\frac{3}{8}$ of this dimension, if such can have taken place after the removal of the superstructure by the explosion, would account for the whole difference. No such movement could have taken place in the north flank, where the Pentelic marble steps rest almost immediately on the hard crystalline rock, and probably remain as they were built.

⁴ The east and west lines of the Erechtheum differ from the level only .014 in their whole length, the *western* end being the lower. Those of the Propylea also fall a very small quantity in the same direction, the north and south lines being perfectly level. In the sub-basement also of the Parthenon the lines of the earlier temple are very nearly level.

⁵ The Greek name *διόπτρα*, derived from the sights on each end, and *Χυροβάτης*, which was probably an improved form of the first, do not allow us to imagine that Vitruvius is describing instruments invented by the

particularity by Vitruvius (VIII. 6) would have enabled them to determine the level plane with great nicety, such as we find was obtained in the instances of other buildings on the Acropolis.

Hence we are led to the conclusion that it was built out of level, and advisedly so, and it remains for us to determine whether this was done for the sake of beauty or for some economical reason, such as drainage,¹ or simply for the convenience of making use of the old lines of the earlier temple.

Before we can admit that the object of this difference of level was to produce beauty, we must be satisfied that such refinement could either be perceived, or felt (without positively knowing its existence), as certainly was the case with the entasis of the columns and the curvature of the horizontal lines.²

The most delicate curve which has ever been applied to any architectural line for the purpose of pleasing the eye is that probably which forms the entasis of the columns of the Erechtheum. In these, the amount of departure from a straight line, or to speak mathematically, the sagitta of the curve, is only .0195 in 21.12, which is equivalent to .108 in 100 feet. The value of the increment of curvature corresponding to the flank of the Parthenon is .156 in 100 feet, so that the curve of the column of the Erechtheum,—a curve confessedly productive of the impression of beauty, is scarcely more than two-thirds as great as that of the stylobate of the Parthenon; we cannot therefore deny that the curvature of the horizontal lines may produce some optical effect of beauty. But the case is otherwise with the differences of level. The amount .158 in 228 feet is equal to about 1 in 1430 or 3.65 feet in a mile. Without the assistance of some kind of optical instruments it is quite impossible that this should produce the slightest effect on the most experienced eye,³ and consequently on whatever other consideration we may be disposed to account for the fact, it can neither produce beauty on the one hand nor unsightliness on the other. It might be further expected that if it had been one of the principles of the Greek architects, Vitruvius, who has so frequently alluded to their optical corrections, would have taken some notice of it.

As to whether this difference of level can have been at all available for the drainage of the temple will come more properly under discussion in the description of the next plate. I will in the meantime explain how it appears to me to have originated.

If, as has been done in the case of the west front, we examine one of the lines of the sub-basement of the south side, shown at the bottom of Plate XII., and which belonged to the earlier temple (compare also Plate IX.), laid down from levels taken at the points indicated by the dotted ordinates, we find that from the western angle to the centre of the flank, the curve of the stylobate of the new temple is almost exactly parallel to this line; and that beyond the centre, as we pass towards the east, the curves gradually approach each other. Thus it appears that the architects of the Parthenon followed the old curve for about half its length, by placing parallel courses upon the original beds, and thus did not require any troublesome tapering of the courses which intervene between these and the marble steps for more than half the extent that would have been necessary had the ends of the new work been kept level. At the same time they effected an object they had in view,—that of increasing the curvature in the new stylobate from an increment equivalent to .105 in the 100 feet to one of .156. Thus, as I have shown above, they made as much use as possible of the old lines; and yet without producing any appreciable optical effect, by the liberty taken with the absolute level. The course which is made to taper is the three fascia course, shown in Plate IX., which decreases only .036 from the west end to the middle of the flank, where it has a thickness of 1.37, but at the east end it is reduced to 1.24, and it will be observed that the amount of this tapering, .166, is just the difference of level.

In Plate XIII. are given four sections of the pavement of the Parthenon, two of them taken through the centre of the temple; the upper transversely, the second longitudinally, the third through the upper step of the Posticum, and the fourth through that of the Pronaos.

Roman Aqueduct engineers. We may also fairly presume that none but an instrument on the principle of the water-level could have been used with precision in the usual state of the Athenian weather. I was obliged to seize every opportunity which the occasional lulls between almost constant and often strong breezes would allow me, to obtain the long plumbs of the columns and other delicate observations.

¹ Fergusson's *Principles of Beauty*, p. 396.

² It cannot be doubted that those travellers who have wondered that the fronts of the Greek buildings were so much less *dry and hard* than our imitations of them, must have felt (however unconsciously) the beauty of

the horizontal curvature; and we may also feel satisfied that the effect of the entasis of the columns in the Parthenon was felt long before its existence was actually established. (See Stuart, new edition, vol. iii. p. 14.)

³ The most experienced person in such matters would probably find his natural appreciation of level fail him in the case of a straight line rising one in five hundred. This may be tested on the gradients of almost any railway. The apparent elevations of distant objects produced by what is called the terrestrial refraction of the atmosphere are often considerably greater than the amount here under consideration, but (except in peculiar cases) this is quite inappreciable without instruments.

They are all referred to the level lines LL, 10 feet above the highest point measured¹ in each case. In the longitudinal section the levels of the columns of the Naos were taken along the southern row.

These sections show that (although not very regularly) a certain amount of rise prevails through the whole building. Whether this could have been required for any purpose of optical effect in the Naos is very doubtful; but we may see that when, besides the stylobate, the steps of the cella had been constructed in convex curves, it was quite as easy to follow out these lines on the central pavement as it would have been to make the area inclosed within the cella walls level.

A modern writer² on this subject, while he recognises the importance of the curvature in the fronts of a temple for optical purposes, considers that the curve in the flanks is merely a "drainage curve," and he considers that his argument is strengthened by the difference of level mentioned above.

It is doubtful whether the advantage thus obtainable from the curvature would have been at all adequate to the necessary complication in the structure. Its tendency would have been to direct any water which had fallen in the impluvium towards the entrance door, and keep it there. For the threshold, which probably continued the line of the small steps³ which encloses the impluvium on every side, would not have allowed it to run off, unless channels had been provided; and, even supposing that this provision had been made, the water on escaping would have flowed northwards and southwards, and remained in the sides of the Pronaos, being retained by another small step, shown in the section, until it either evaporated, or was otherwise removed.⁴

Again, the transverse section in Plate XIII. shows that the edge of the small steps surrounding the impluvium, and which carried the columns of the Naos, is considerably (.07) higher than the pavement at the cella walls. This could have had nothing to do with the drainage of the impluvium, since, if any water, by the action of the wind, fell outside the impluvium, it would have made its way to the side walls, and there remained. We may further observe, that the curvature of the pavement is rather more considerable in that portion of the stylobate of the peristyles, corresponding to the length of the Naos,⁵ than it is in the Naos itself; which is contrary to what might have been expected had the curvature in the former been ruled by the requirements of the latter. Lastly, there is a passage in Pausanias,⁶ from which it may even be gathered that the evaporation of water was considered essential to the preservation of the ivory of the statue of Minerva. We may therefore be satisfied that the consideration of drainage had little if anything to do with the convexity of pavement given to the flanks of the temple, and as a sufficient explanation has already been brought forward of the elevation above the level of the south-west angle, we need have no further hesitation in accepting the reason given by Vitruvius, that it was adopted, "ne alveolatus oculo videretur." I shall attempt in Chap. XV. to consider the causes which would produce this apparent alveolation in a rectilinear construction.

Above the longitudinal section in Plate XIII. is given an elevation of the ὀρθοστάται or high course of slabs which forms the base of the cella wall. We here see that in the middle of the flanks these stones are about .07 less in depth than at the ends near the antæ, so that the increment of curvature, measured on the upper bed of these stones, is diminished from .18, which we find on the upper step of the cella, to about .11 in 170 feet, equivalent to .165 in 100. This was doubtless intended to lessen the amount of curvature in the beds of the cella wall, either for the purpose of rendering them more easy to be worked, or, what seems more likely, in order that the artifice of curvature should not be too visible at the level of the eye of persons walking in the peristyles, and looking along the narrow set off (about .026) which marks the upper line of the *orthostatae*. The destruction of the middle part of the cella walls renders this point difficult to be determined, as also in which course of the wall the compensation for this difference made in the *orthostatae* takes place; for at the top of the wall it was necessary

¹ These lines must not be confounded with each other. The level line used in the longitudinal section, is .005 foot above the similar line in the transverse section; .252 above that in the Pronaos step, and .128 above that in the Posticum.

² The late Mr. Fergusson, in page 396 of his valuable work, cited above.

³ Although the actual pavement under the Pronaos door has been destroyed, the courses upon which it rested remain, and there appears to be sufficient reason to conclude that there was such a threshold.

⁴ Whenever a shower falls on the Acropolis sufficient to produce standing water on the pavement of the Parthenon, it forms two small pools in the Posticum, one on the north and another on the south. The pave-

ment of the Pronaos has been too much disturbed to retain the water.

The generally dry climate of Athens rendered provisions for carrying off the water from the interior of the temple, which would probably be very small in amount, of less importance than in other places, such for example as Messene, where gutters were amply provided. (See *Expédition Scientifique de Morée*.) Very heavy rain, however, falls occasionally at Athens.

⁵ In the Naos (*vid.* Longitudinal Section) the slope eastwards from the centre of the building to the Pronaos door is .127 foot; in the same length on the external stylobates, it is .170 on the north, and .178 on the south.

⁶ Paus. 11. 5 (compare Leake, p. 564).

that the courses should recover their parallelism to the external entablature, otherwise the lines of the coffers of the ceiling would have been at fault.

Plate XIII. also contains measurements of the "scamilli impares" from some of the lower drums of the columns of the Pronaos and Posticum; and the projection on the upper step of the stylobate (by plumbing) of the abaci of the four angle columns.

*Adjecere bonæ paulo plus artis Athenæ
Scilicet ut possem curvo dignoscere rectum.*



CHAPTER IV

ON THE INCLINATION OF THE COLUMNS OF THE PARTHENON AND OTHER ATHENIAN BUILDINGS

THE external columns of the Parthenon, Propylæa, Theseum, and Erechtheum are found not to have their axes perpendicular, but to be inclined inwards, at a uniform angle in each building; so that the axes of every pair of opposite columns, if produced far enough, would meet at a great height above the building.¹

The present amount of this inclination in the case of the eight columns of the eastern front of the Parthenon is recorded in Plates VII. VIII. and XIII. by means of the positions of their abaci projected by plumbing upon the pavement.

As the columns have been nearly all disturbed, though very slightly, from their original positions, no single instance is quite conclusive. An average of all would not differ much from the value of the original inclination. However, two methods present themselves even more certain than that

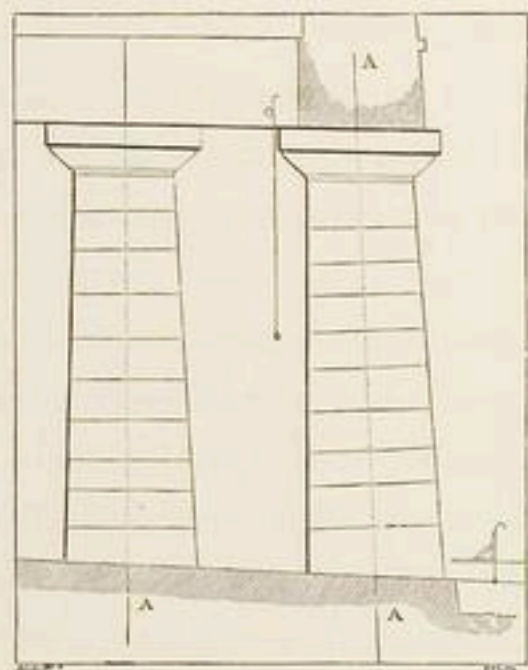


FIG. 3.

¹ A figure which would correctly explain the inclinations of all the columns of the Parthenon, is that of the framed rafters of a very steep roof, hipped at both ends, constructed on an oblong plan similar to that of the temple. The *hip rafters* would represent the axes of the angle columns produced, receiving at different heights the intersections of the three adjacent pairs of columns on each side of the angle. The ridge which would receive the intersections of the nine central pairs on each flank, would, on a scale equal to the real building, be 5856 feet in height above the pavement. With the exception of those at the angles, the axes of the columns on each front or flank are parallel to one another; while the angle columns participating in the inclination of the two contiguous colonnades have a greater inclination than the ordinary columns, in the proportion of the diagonal to the side of a square.

² Of these the result from the east front is the most complete, as I was enabled to take into account the cracks both on the inside and outside faces of the architrave. The architrave of the western front has been so much shattered on its outside face, that the inside only could be measured with exactness.

³ The average difference of the lower scamilli impares of the east front is .0902. Of this the quantity due to horizontal curvature is .0437. These measurements from the west front are respectively .0758 and .029,

of averaging their partly accidental variations. The first is that of projecting the axes of the angle columns on to the pavement, taking into account all such cracks and shifts as may have occurred in the architrave, by which the inclination of the columns has been affected. We thus obtain .221 from the east end; and .205 from the west² as the original value in the whole height of the columns. The other method is that of averaging the differences of the scamilli impares of many columns, and deducting from this sum the amount due to the curvature of the horizontal lines, obtained by levelling in each case. These differences, whether taken from the east or west fronts, from the upper or lower scamilli, combine in a remarkable manner to give .231³ as the amount of inclination in the entire column.

leaving in the former case .0465, in the latter .0468 as the amount due to the inclination of the columns. That is to say, a line perpendicular to the axes of the columns (namely the lower diameter within the flutes) has been affected to this extent by the inclination of the columns from the perpendicular; and the following proportion, viz. $\frac{\text{Inclination in shaft}}{.0466} = \frac{31.43}{5.873}$ will give the amount in the height of the shaft, namely .249. The difference in the upper scamilli impares, averaged from five of the middle columns of the east end, is .067. The amount due to curvature in these is .031, leaving .036 for the result of the inclination on a length of 4.56. Measurements from the two eastern angle columns, and from the south-western give .0617. In these the amount due to curvature is .0245, leaving .0372 for the effect of the inclination on a length of 4.66, or .0363 in 4.56; and the resulting proportion is $\frac{.249}{.0363} = \frac{31.43}{4.56}$. To obtain the inclination in the whole column including the capital, the quantity .249 must be reduced by .018; because the axis of the capital is not in the same line as that of the shaft, but is perpendicular to the lines of the horizontal curvature, and consequently leans forwards in a contrary direction to that of the shaft. This adaptation, while it considerably facilitated the working of these members, is quite imperceptible to the unaided eye.

These two methods converge so as to fix the quantity sought within very narrow limits. It appears highly probable that .228 was the original amount in the whole height of the column (namely in 34.26), which, being at once a submultiple of the height of the column, producing an inclination of exactly 1 in 150, and proportional to the semi-diminution and entasis (see Chap. V.) (being $\frac{1}{3}$ of the one and 4 times the other), is also identical with the increment of curvature in the fronts; which, as before stated, measures .225 in the eastern and .230 in the western fronts, averaging .2275. We thus find the following simple relation among these small quantities of like nature; semi-diminution 12, increment in front 4, inclination also = 4, entasis 1.

The vertical faces of the architrave and frieze have an analogous and parallel inclination, only rather greater in amount. In Plates VII. and VIII. the plumbs are given exactly as they were taken. In Plate XVI. the horizontal shifts are corrected. The result thus obtained seems to point out an inclination of 1 in 80 as the original amount of batter. The tympanum appears to incline backwards 1 in 100; and the steps at a less angle, not exceeding 1 in 250, which is about half the initial angle of the horizontal curvature on the stylobate. The vertical faces, on the other hand, of the cornice and the members above it, namely, the fillet of the wall tile, the acroteria, and the antifixæ, incline forwards in the same direction as the face of the abacus which has been before mentioned. The amount in the depth of the face of the cornice appears to have been .012, which is just 1 in 100, about equal to twice the initial angle of the horizontal curvature in the architrave. The faces of the acroteria towards the flanks, and the antifixæ, lean forwards $\frac{1}{20}$ of their height. The upper surface of the acroterium makes a right angle with the vertical face, and consequently an angle whose tangent is $\frac{1}{20}$ with a level plane; it thus harmonises much better with the raking lines of the pediments than it would have done had it been itself level. This is best shown in the section in Plate XVII. All the inclinations which have been observed in the Parthenon are found in similar parts of the Propylæa, and generally also in the Theseum. (See Chaps. X. and XI.) The sides of the beams of the ceiling, and almost all the other flat surfaces, are inclined backwards or forwards according to the situations where they are placed; and generally we may remark that perpendicular faces are the exception and not the rule. In his third book Vitruvius distinctly mentions these modifications of the perpendicular, and gives the following rule for the inclination of columns—

"Spiris perfectis et collocatis, columnæ sunt medianæ in Pronao et Postico ad perpendicularum medii centri collocandæ. Angulares autem, quæque e regione earum futuræ sunt in lateribus ædis dextra ac sinistra, uti partes interiores quæ ad parietes cellæ spectant, ad perpendicularum latus habeant collocatum."

Thus translated by Mr. Wilkins—

"The bases being fixed in their places we must proceed to rear the columns of the Pronaos and Posticus; all of which, excepting those at the angles, should have their axes in a vertical line; but the columns at the angles, as well as those which are intended to be placed in the flanks, should have their axes inclined, so that the faces next the walls of the cella may become perpendicular to the stylobate" (may have their inner sides perpendicular).¹

We find that the axes of the four middle columns of the inner order of the Posticum differ from the perpendicular by only a very small quantity, and that easily accounted for, while at the same time their scamilli impares (see Plate XIII.) have only a difference sufficient to correct the curvature of the horizontal lines. Hence we must conclude that they were originally perpendicular, while the axes of the angle columns, although now somewhat disturbed, can be satisfactorily shown to have had about the same inclination towards the centre of the portico as the external columns of the peristyles. This is also distinctly confirmed by the measurements of the scamilli, of which the difference north and south is greater than it is east and west. The average of the two measurements recorded indicates an inclination of 1 in 148 in the shaft of the column. So these columns (namely the angle columns of the inner order) would have appeared perpendicular when viewed from the north or south, but inclined when seen from the east or west. Vitruvius in another passage (iii. 3), in which,

¹ The inclination of the columns in the Athenian buildings is not so great as that which would result from the rule here given by Vitruvius; but, as he is speaking of the Ionic order, in which the diminution is so much less than in the Doric, it is evident that in some very good examples this method may have been applied without exceeding the actual angle of

inclination in the Doric examples. In the column from the northern portico of the Erechtheum indeed, given in Plate XIV., the inclination is much less than the semi-diminution, and I believe it is near the correct amount. This temple, however, was not subjected to so thorough an examination as the Parthenon and Propylæa.

however, the numeral is probably corrupt, records the principle of giving the inclination to the faces of the entablature, etc., which has already been noticed in the Parthenon.

"Membra omnia, quæ super capitula columnarum sunt futura, id est epistylia, zophori, coronæ, tympana, fastigia, acroteria, inclinanda sunt in frontis suæ cujusque altitudinis parte duodecima."¹

"All the members above the capitals of the columns, that is to say, epistylia, zophorus, coronæ, tympanum, fastigium, and acroteria, ought to have an inclination towards the front equal to a twelfth part of the height of each."—(Wilkins's translation.)

According to Vitruvius, all these members should incline forwards. In the Athenian buildings the more considerable faces incline backwards, and the subordinate only, forwards.

There is also a passage in Cicero which shows that the inclination of the columns was a recognised principle among the ancients.²

Thus far the monuments and the written page on the whole confirm one another. In the following peculiarities the Parthenon and the Propylæa (see Plate XVI. and XXX.) are our only authorities, at least at Athens, for I could not discover them in the Theseum. In the Parthenon the transverse wall of the cella which contains the door of the Posticum is perpendicular, but the side walls which have nearly the same thickness above as below, incline in the same direction as the columns. The result of the plumbs after correction for horizontal shifts shows that this inclination probably amounted to 1 in 80. But, what is still more remarkable, the western faces of the antæ lean forwards at the same angle, so that the capitals of the antæ overhang their bases considerably. There can be no doubt that this obtained in the original structure of the temple, and has not arisen subsequently from settlement or other disturbance; for the joints of the cella wall are placed perpendicularly over one another, but the upper stones of the extremities of the walls, and which form the antæ, are made just so much longer than those in the lower courses as to produce this result.³

I shall reserve any observations on the reasons which probably led to the above-mentioned modification of the ordinary forms of construction until Chap. XV., which treats of the optical corrections in general; adverting only to the delicate effects of light and shade which these varieties in the position of the different planes produce, especially when light falls very obliquely upon the fronts or flanks of the temple.

¹ Is it possible that the proper reading may be XL^{ma} instead of XII^{ma}? An inclination of 1 in 40, although greater than is found in the Parthenon generally, would not under certain circumstances be excessive.

² Cicero in Verrem (Act II. lib. i. 51.) speaking of a visit paid by Verres to a temple at Syracuse. "Venit ipse in ædem Castoris: considerat templum: videt undique tectum pulcherrimè laqueatum: præterea cætera nova, atque integra: versat se: quærit, quid agat. Dicit ei quidam. . . . Tu Verres! hic quod moliare, nihil habes, nisi fortè vis ad perpendiculum columnas exigere. Homo omnium rerum imperitus, quærit, quid sit, ad perpendiculum. Dicunt ei, fere nullam esse columnam, quæ ad per-

pendiculum esse possit. Nam Mehercule, inquit, sic agamus: columnæ ad perpendiculum exigantur."

³ The length of one of the lower stones of the cella wall which is connected with the ante of the Posticum at a height of 5.6 above the base, is 4.535; at 29.63 above the base the length of the stone becomes 4.828, giving a difference of .293 in 24.03, equal to 1 in 82. There is more difficulty in getting satisfactory measurements from the southern anta, but the differences are analogous. In a height of 10.3 feet I found a difference of .107, which amounts to 1 in 96.

CHAPTER V

ON THE ENTASIS OF THE COLUMNS OF THE PARTHENON AND OTHER ATHENIAN BUILDINGS

PLATES XIV. XXXIII. XXXV. XXXVII.

THE entasis (from *ἐντείνω* to stretch a line or to bend a bow, *adjectio in mediis columnis*, Vitruvius, Lib. III.), is the well-known increment or swelling given to a column in the middle parts of the shaft for the purpose of correcting a disagreeable optical illusion, which is found to give an attenuated appearance to columns formed with straight sides, and to cause their outlines to seem concave instead of straight. The fact is almost universally recognised by attentive observers, though it may be difficult to assign a conclusive reason why it should be so.¹ The entasis, by means of which this appearance is obviated, gives to the profile of the column a delicate convex curve, extending from the base to the neck; and introduces just so much addition in the middle (and no more), as was found, perhaps from experiment, sufficient to counteract the apparent deficiency; without giving in the slightest degree, at least to the ordinary observer, the appearance of a curved line. This optical correction seems to have been applied by the Greeks from the earliest times.²

In the Parthenon, Erechtheum, and Theseum, the entasis has been so delicately applied that until a comparatively recent period³ the columns of these temples were supposed to be perfectly straight, and are so represented by Stuart. Indeed, unless an observer, by accident or intentionally, looks exactly along the line of the flutes from the top or bottom of the shaft, the curvature is scarcely appreciable, except by its indirect effects, even to the most practised eye.

Plate XIV. gives an elevation of one of the columns of the peristyle of the Parthenon and one from the north portico of the Erechtheum.

It will be convenient to anticipate in this chapter so much of the explanation of Plates XXXIII. XXXV. and XXXVII. as refers to the subject of the entasis. The first relates to that of the Doric columns of the Propylæa, the second to those of the Theseum, and the last to the Corinthian order of the Temple of Jupiter Olympius. The columns are all drawn to the same scale, $\frac{3}{8}$ of the real size, and their shafts are turned at such angles as show their full diameters. The magnitudes of the entasis in the different examples may be arranged in the following order—

¹ An attempt to explain the theory of the entasis is given in Chap. XV.

² In the temple at Corinth, which is generally accepted as the most ancient example of Greek Doric, the state of the columns is such that, without rigid examination, it is impossible to come to any positive conclusion. My impression, however, from such observations as I could take from below, is that a slight entasis would be discovered by proper measurements. In the early examples of Jupiter Panhellenius at Ægina, and the Temple of Neptune at Paestum, the entasis, though delicate, is distinctly perceptible. The Basilica at Paestum of which the entasis is so conspicuous, is supposed by Mr. Fergusson (*Principles of Beauty and Art*, page 367), to be a barbarous copy by the Lucanians of the Sybarite Temple; but not even here do we meet with the extreme to which it has been carried by almost all the great Italian architects, with the exception indeed of Brunelleschi, that of making the diameter of the column at about $\frac{1}{3}$ of its height, actually larger than at the base. In no one of the Athenian

examples, except Jupiter Olympius, is the profile of the column even perpendicular at the base; the entasis is kept subordinate to the diminution; and, as may be seen by reference to the exaggerated figures at the side of Plates XIV. and XXXIII. (where the scale of the entasis is exaggerated $12\frac{1}{2}$ times), the profile of the shaft at the base makes a sensible angle with a vertical line parallel to the axis of the column. Compare also the entasis of the columns of the Pantheon at Rome given by Desgodetz. *Édifices Antiques de Rome*.

³ See Chap. III. p. 23. The entasis of the columns of the Parthenon, Theseum, and Erechtheum is so much more delicate than it is in the Roman and Revived Classical examples, with which only the earliest travellers in Greece were acquainted, that they seem to have overlooked it altogether. That of the large order of the Propylæa might have been perhaps more readily discovered, if the columns of that structure had not been greatly encumbered with Turkish buildings.

Buildings.	Length of shaft exclusive of Apo- phyge, etc.	Maximum entasis.	Height of the maximum entasis above the stylobate.	Comparative entasis in a shaft 31.43 feet in length.
Erechtheum, North Portico	21.12	.0195	$10.42 = \frac{1}{2}$ of the height of column.	.029
Theseum	17.1	.023	$8.7 = \frac{1}{2}$ shaft	.042
Parthenon from the peristyles	31.43	.057	$13.8 = \frac{2}{3}$ column	.057
Propylæa—Small order	17.5	.0343	$9.33 = \frac{1}{2}$ column	.0615
Ditto Large order } from Eastern Portico }	25.6	.0627 or 1 diacryl = .0633	$13.75 = \frac{1}{2}$ column	.077
Jupiter Olympius	43.70	.118	$18.4 = \frac{1}{2}$ height of the column	.084

The numbers in the last table might with very little error be reduced to 4, 6, 8, 9, 11, and 12. On the left hand of Plate XIV. is given an exaggerated view of the entasis, measured on the edge of one of the exterior flutes, of the fourth column from the north-east angle, on the east front. The edges of the flutes in those columns which had been best preserved from injury, were found to have more regularity of curvature than any profiles which could be obtained within the channels, and moreover to be themselves generally somewhat more regular on the outside of the temple than on the inside towards the cella walls, which parts being usually in shade, did not demand the same absolute precision as those where the slightest defect would be made visible by the cast shadow.

I have given in the plate the best preserved specimen I could find; but the exactness of the curvature in this case is by no means peculiar, as may be seen by the other examples given in the Appendix, Art. 16.

The entasis, as shown in Plates XIV. and XXXIII. and XXXVII., was measured in the following manner. The edge or arris of a flute at the bottom of the shaft was first selected, or its position recovered, if defective, by completing on the pavement the contour of the contiguous flutes, according to their ascertained law (see Plate XXI. Fig. 14). The edge was usually perfect at or near the neck. A fine harp wire was then brought as near as was convenient to these two points, and strained by means of weights as tight as it would bear. The offsets between the wire and the most perfect surfaces presented by the column were then measured with a rule provided with a slide joint, and read off by means of a vernier. Care was taken to obtain, whenever possible, two measurements in each stone, and the amount of the shifts at the joints was also ascertained. By this means, since generally no movements, excepting horizontal shifts, can have taken place (see Chap. III. Sect. 2), if the surface be sufficiently well preserved, of which, in carefully selected places, there is little doubt, the exact form can be recovered.

Table 1 in the plates gives the heights above the pavement where these offsets were taken.

Table 2 the offsets exactly as they were measured.

Table 3 the same, corrected by means of the measurements of the horizontal shifts.

In Table 4 the offsets which hitherto were measured horizontally from the strained wire, are transferred by calculation, so as to be measured (also horizontally) from an imaginary vertical straight line YY' parallel to the axis of the column, and passing through the point Y' , which in the example before us from the Parthenon is the extremity of the lower diameter of the column. The amount of the inclination of the axis of the column is indicated by the plumb-lines in each case.

From the measurements here recorded we may endeavour to determine the nature of the curve employed.

I have found the entasis in every case so nearly resembling one of the forms of the conic sections, viz. the hyperbola (Fig. 2 Plate XLVII., see also Appendix, Art. 4), that I cannot doubt that this was the curve used in the columns of the Athenian structures. This is the more likely, because we may be satisfied that these curves, although their invention has been assigned by mathematical writers to a later age, were nevertheless certainly known, though perhaps not as sections of the cone, to the builders of the Parthenon, as will be shown when we come to the subject of the profiles of the mouldings in Chap. VII.;¹ and although perhaps some of these

¹ It is not unlikely that the curves of the second order of which we are speaking were known to the Greeks even at a much earlier age. The measurements given of the echinus of the capitals of the temple at Corinth (see Stuart and the *Expédition Scientifique de Morée*), and those of

examples of entasis from the extreme delicacy of their curvature might be successfully compared with other regular curves known to the ancients, such for instance as the conchoid of Nicomedes, Fig. 1, Plate XLVII., the entasis of the columns of the Propylæa, as far as I am aware, can be reduced to no known simple curve, except the hyperbola; and there is strong internal evidence that the columns of the Parthenon are of the same nature. In the Appendix, in the description to Plate XLVII., will be found a short description of the different curves employed, or supposed to be employed in the Athenian buildings; and I must beg the reader to refer thither for their definitions, and also for the names of their different parts, etc., which I shall use here without further explanation.

To begin with the entasis of the Parthenon.

In searching out the nature of this curve, it may be worth while to try how nearly it coincides with a circular arc passing through the upper, lower, and middle points.¹ It may be shown that the curvature of the column is much quicker than that of the circle in the lower, and flatter in the upper half, and the circle gives no satisfactory approximation; neither would an ellipse nor even a parabola, applied as usual, at their vertices materially alter the case. Had the corresponding segment of a parabola been used instead of the circle, the approximation would have been carried only .0003 nearer; and even the conchoid of Nicomedes, unless placed obliquely, would fail to give a satisfactory resemblance; but if the hyperbola be tried, we find not only a wonderful agreement at all points, but the geometrical axis of the curve is parallel to the axis of the column. In Table 5 in the plate, in which are given the ordinates to an hyperbola obtained by calculation, we find the following correspondence of measurements—

Height.	Offsets of Hyperbola.	Offsets to Column.
0	0	0
8.7	.1392	.1397
15.75	.2875	.2886
23.0	.4613	.4618
31.43	.684	.684

none of which differ more than one thousandth part of a foot, which is just the space occupied from centre to centre in Plate XIV. by the lines drawn to indicate the fillet between the flutes of the Ionic example. In the other measurements the correspondence is scarcely less complete, and we may be satisfied that we have here as perfect identity as it is practicable to attain.²

The entasis of the columns of the Posticum (Inner order) seems to be identical with those of the peristyles. An example of one of these columns will be given in the Appendix, Art. 17.

In the column of the northern portico of the Erechtheum on the right hand of the plate, which also is drawn so as to present its full diameter, the entasis has been measured precisely in the same manner as in the previous example. The offsets are transferred to the straight line YY',³ and are compared

the Temple of Jupiter Panhellenius, Ægina, and of Jupiter at Olympia by the last mentioned authority, also the sections, from the early examples at Athens given in page 6 of this work, point to one of the conic sections as the form probably used in those early buildings.

¹ We may find by calculation what is not manageable in practice in geometry, the radius of a circle passing through the above-mentioned points, namely coinciding with the column at the heights 0, 15.75, and 31.43 (see Table 1 in the plate). The radius of such a circle would be 2280 feet; which dimension, just 10 times the length of the flank of the temple, may indeed point to some analogy followed in the selection of the amount of the entasis; but the offsets obtained from this circle differ very considerably from its curvature; for if we compare them at the nearly intermediate heights, 8.7 and 23.0, the result which we obtain is as follows—

Height.	Offsets in the circle.	Offsets from the entasis of the column.
0	0	0
8.7	.1464	.1397
15.75	.2886	.2886
23.0	.4585	.4618
31.43	.684	.684

² Besides the correspondence of the measurements, the relations among the elements of this curve are such as to give great additional confirmation.

The rectangular axes of this figure are vertical and horizontal, that is, parallel to the architectural lines of the column.

The principal lines is 1 Attic foot = 1.0134 foot.

The eccentricity, or constant ratio, is as the integral number 30 to 1, it may be stated in addition, that the radius of curvature of this hyperbola at the point coinciding with the base of the column is five times the length of the building. The distance of the vertex below the base is just 2 diameters, and the maximum entasis, which is exactly $\frac{1}{12}$ of the half diminution of the column, is produced by this hyperbola at the height of 13.8 feet above the stylobate, just $\frac{2}{3}$ of the height of the column.

The value of the proofs of design in the relations among the elements of the curve arises from the fact that in consequence of the absence, in the segment employed in the case of the Parthenon, of the vertex of the curve (or the point on each side of which the curvature changes symmetrically), and its extreme delicacy, it might be possible to find other regular curves which should coincide almost as well with the measurement as that from which Table 5 is calculated. But there is no such ambiguity respecting the nature of the curvature used in the columns of the Propylæa and Erechtheum, for in these examples the vertex occurs near the middle of the shaft, and the curves can be proved to be hyperbolas, having also generally some simple relations among their elements.

³ This straight line is not, as in the former instance, perpendicular, but lies obliquely with regard to the axis of the column. YY' is in fact the

M

with the ordinates of an hyperbola, measured from the same straight line; and the approximation to the entasis is found to be quite as accurate as in the previous example. The half diminution in this case is .1775, so that the entasis is just $\frac{1}{5}$ of that quantity.

ENTASIS OF THE PROPYLÆA.

Turning to Plate XXXIII., which gives the entasis of the columns of the Propylæa, we find examples taken both from the larger and smaller orders.¹ They are measured precisely in the same manner as the examples in Plate XIV.

In the case of the larger column the difference between the offsets in Tables 4 and 5 does not exceed .002, and the theoretical curve threads its way among the measured points of the actual curve in a manner scarcely less satisfactory than even a more perfect coincidence would be. This example is taken from the northern column of the eastern portico. The maximum entasis, .0627, amounts exactly to one dactyl, and the half diminution, .57, to 9 dactyls exactly. In the small order the maximum entasis = .0343, and the half diminution is .388, so that the former is almost exactly $\frac{1}{11}$ of the latter. This entasis is rather more delicate than in the large order (see Table of Comparative Entasis), it being probably considered, as I have before observed, that a small column required less relative entasis than a large one. This example, taken from the middle column of the northern wing, is very well preserved, and in none of the examples here given does the calculated hyperbola agree more nearly with the measured entasis.

There is one remarkable difference between the entasis of the columns of the Parthenon and that of the three examples last mentioned. It will be seen in Plates XIV. and XXXIII. that the measurements are in each case referred in Table 4 to the line YY', which line is either itself the vertical axis passing through the centre of the approximating hyperbola, as in the three last examples, or parallel to that line, as it is drawn for the sake of convenience in the first example. In the column of the Parthenon only is the line vertical; in the others it is inclined, and is nearly parallel to the chord of the curve which forms the entasis.

It will be seen by inspecting the offsets from these lines in Tables 4 and 5, in the case of the examples from the Propylæa and Erechtheum, that they increase uniformly at similar distances on each side of a certain point; which shows that the vertex of the curve is contained within the segment producing the entasis of the column; and the height where the vertex occurs, although differing in the different columns, in all is considerably above the base. In the case of the Parthenon, however, the vertex of the curve is excluded from the column, and if the line were continued, would occur just two diameters below the stylobate. If we compare the columns of the large order of the Propylæa with those of the Parthenon, we shall find that considerable variety of character results from this difference in the position of the vertex of the curve; although, owing to the delicacy of the entasis in both cases, the difference was rather to be felt than recognised before the measurements were taken. In the Parthenon the curvature decreases continually with the height of the column, and the variation is comparatively limited. In the Propylæa and the other two examples, the curvature increases from the base up to a certain point, and then decreases, there being at the same time very great variety between that at the middle of the column and at the extremities. In the hyperbola, which approximates to the entasis of the columns of the Parthenon, the radius of curvature at the point intersecting the stylobate is 1143 feet; which is remarkable as being exactly five times the length of the flank of the temple. At the point answering to the neck of the column it is 4915 feet, or 4.3 times greater than at the base. In the case of the entasis of

vertical axis of the hyperbola, which has been found to approximate most nearly to the entasis and passes through its centre C. The elements from which Table 5 has been calculated are—

$$a = .0203 = \frac{1}{50} \text{ Greek foot.}$$

$$e = 275.$$

The height of the vertex is 7.25 feet above the torus of the base, just $\frac{1}{2}$ the height of the column above the stylobate.

¹ In the larger order the vertex of the curve occurs 14.12, just $\frac{1}{2}$ the height of the column above the stylobate.

The principal axis of the curve $a = .0253 = \frac{1}{40}$ Attic foot.

The constant ratio $e = 150$

In the small order $a = .1126 = \frac{1}{9}$ Attic foot.

$e = 90$

So that the focal distance $ae = 10$ Attic feet.

The height of the vertex is 11.38 above the pavement, just $\frac{2}{3}$ of the height of the column.

the larger order of the Propylæa, the radius of curvature at the vertex is 569.2 feet;¹ that at a point 14.12 distant, answering to the base of the column, is 32,500 feet; about 57 times greater than that at the vertex. Indeed the curvature at the vertex is very considerable, for in the circle of 570 feet radius the sagitta corresponding to a chord of the length of the shaft would be .143 foot; whereas in the circle of curvature at the base it would not amount to .003, and therefore would be quite inappreciable. If in the comparison of these two beautiful examples we should feel inclined to attribute a superior degree of elegance to the columns of the Parthenon, it must probably result from these two circumstances, viz. that the range in the variation of the curvature is more delicate, and, as the vertex of the curve is excluded from the column, there is no repetition of similar curvature on each side of it.

ENTASIS OF THE THESEUM.

In Plate XXXV. are given measurements of the entasis from two selected columns of the peristyle of the Theseum.

In these columns the cusps or edges of the flutes are very delicate, and were found to have been so much injured that I was obliged to measure the curve of the entasis within the channels, which, as has been before said, is not so perfect in its curvature as the edge of the flute. None of these measurements, taken separately, give that regularity of curvature which has been found in the examples previously produced; but if we take the mean of the four measurements, we shall see more distinctly what was the curve intended—

Heights.	Offsets obtained from the mean of the four measurements.	Corresponding hyperbolic ordinates. ²
17.07	.0447	.0447
14.66	.0362	.0355
12.22	.0281	.0281
9.72	.0234	.0235
7.26	.0238	.0240
4.65	.0294	.0289
2.13	.0364	.0365
0.	.0447	.0447

which is as near a correspondence as could be desired.

In the other examples an average obtained from measurements inside the flutes would no doubt have given an equally accurate result, but the examples in Plates XIV. and XXXIII., which were measured along the edges of the flutes, are more satisfactory, for they are all drawn from single specimens, which were selected only on account of the good preservation of the columns from which they are taken.

The semi-diminution in the columns of the Theseum is .3855, probably derived from the angle abacus, which is 3.856 broad. The entasis obtained by averaging the four measurements is .023, which is probably intended for $\frac{1}{16}$.3855, which amounts to .0241.

ENTASIS OF THE COLUMNS OF THE TEMPLE OF JUPITER OLYMPIUS.

In Plate XXXVII. are given the measurements of the entasis of one of the exterior columns³ of the southern flank of the Temple of Jupiter Olympius, measured along the fillet of the flute. This entasis, although not quite so beautifully regular as that of the preceding examples, is nevertheless deserving of

¹ This is remarkable as being just half that at the base of the columns of the Parthenon, for $2 \times 569.2 = 1138.4$.

² The elements of the hyperbola, from which this table is calculated,

are $a = .0229$, = maximum entasis very nearly.

$c = 223$.

The vertex appears to be at a height of 8.7, just the middle of the shaft.

³ The third column from the east. I selected this column for examination rather for the sake of the remarkable preservation of its capital than for the perfection of its entasis, which was not quite so well preserved in the lower part of the shaft as in one or two of the columns of the inner row; but as this was tolerably perfect, and the appliances necessary to measure another example of this gigantic order would have involved considerable difficulty, I thought it unnecessary to obtain any further specimens from this temple.

notice. The measurements are given in the same manner, and compared after the usual corrections with an hyperbola, which may with considerable probability be proposed as the curve which produced the profile of the column.¹ The $\frac{1}{4}$ diminution is .457; the entasis as measured .118. This is so nearly $\frac{1}{4}$ of the semi-diminution, which again is almost exactly $\frac{1}{4}$ of the lower diameter, that we may be justified in assuming that these values determined the diminution and the entasis. According to Vitruvius, the diminution of a column of this height should be $\frac{1}{8}$ of the lower diameter, and the entasis, = the fillet of the flute, = .133.²

We may conclude this subject with a table of the amount of the entasis in the different examples, stated in terms of the length of the shaft and of the semi-diminution of the columns—

	Entasis in terms of length of shaft.	Ditto in terms of lower diameter.	Ditto in terms of semi- diminution.
Erechtheum	$\frac{1}{1080}$	$\frac{1}{134}$	$\frac{1}{9}$
Theseum	$\frac{1}{708}$	$\frac{1}{146}$	$\frac{1}{16}$
Parthenon	$\frac{1}{552}$	$\frac{1}{116}$	$\frac{1}{12}$
Propylæa Small order	$\frac{1}{500}$	$\frac{1}{100}$	$\frac{1}{11}$
Ditto Large order	$\frac{1}{400}$	$\frac{1}{80}$	$\frac{1}{9}$
Jupiter Olympius	$\frac{1}{352}$	$\frac{1}{66}$	$\frac{1}{8}$

¹ As the lower part of the curve has been so much worn that it is impossible to expect a coincidence at the bottom, and the upper portion may have been a little *humoured* to accommodate it to the dimensions of the capital, I have chosen the points for coincidence between the hyperbola and the entasis at the heights marked 10.7 and 38.1. In this length of 27.4 feet the measurements of the entasis agree with the hyperbolic

ordinates within .002, except in a solitary instance. The elements of the hyperbola are, $a = .1375$, just $\frac{1}{8}$ of the entasis, and $e = 90$. The vertex occurs at 9.4 feet above the torus of the base, just one fourth of the height of the columns above the plinth.

² Vitruvius, B. III. 5. According to this rule the entasis of the Erechtheum north portico would have been .036, but it is only .0195.

CHAPTER VI

MISCELLANEOUS DETAILS OF THE CONSTRUCTION OF THE PARTHENON

PLATES XV. XVI. XVII. XVIII.

THE plan of the ceiling of the Posticum of the Parthenon, given in Plate XV., has been put together from measurements and plumbs of the existing beams *in situ*; and the coffers have been arranged by the observation of the cramp-marks remaining on the beams, aided by a few fragments of the coffers themselves.

Of the smaller coffers over the Posticum, the fragment given in this plate was sufficiently well preserved to enable the whole to be completed with certainty, and the larger coffer contained in itself data of great use in calculating the original dimensions, namely the traces of the two rows of eggs of different sizes painted on the ovolo mouldings. One result calculated from these data gave 4 Greek feet from centre to centre of the coffers, agreeing exactly with the average distance between the cramp-marks on the wall beam running along the peristyles, and falling in very exactly with the breadth of the space left between the cella walls and the external entablature. This restoration is further confirmed by the symmetrical manner in which alternately a coffer and a beam coincide with the columns of the peristyle. I did not find any fragment of the coffers of the six middle spaces of the ceiling over the peristyles of the fronts. But the ratio of the sides of the opening, bounded by the walls and the marble beams in the Posticum, together with the cramp-marks on the beams, leave no reasonable doubt as to the way in which the ceiling was arranged.¹ There can be little doubt but that the insides of these coffers were painted in a similar manner to those of the Propylæa, given in Plates XXIV. and XXV.² The ceiling of the Pronaos, which has entirely disappeared, was no doubt almost an exact counterpart of that of the Posticum.

Plate XVI. gives a transverse and a longitudinal section through the Posticum of the Parthenon.

The restoration of the ceiling is in accordance with the previous plate. In the restoration of the timbers of the roof I have been guided by the recesses remaining in the back walls of the western pediment, which were clearly intended for the insertion of the main supports of the roof. I have suggested in the plate that these were huge *purlins* or longitudinal beams of timber, but the great size of the above-mentioned recesses makes it not improbable, as has been already mentioned in Chap. II. page 14, that they were of marble; and we may further presume that there were no framed trusses of timber except in the Naos. In the Temple of Theseus (see Plate XXXV.) similar recesses are seen, but of so much smaller a size, while the length of bearing is even greater than in the Parthenon, that it is plain that timber must have been the material there provided.

The plumbs which are given in this plate scarcely differ from those actually taken, but the small irregularities which have arisen from horizontal shifts have been corrected.

The frieze has generally been constructed hollow, thereby economising material, and relieving the architrave from unnecessary weight. The central part of the tympanum, which is formed of single stones in height, has been constructed in the same way, and is connected with the backing by strong iron cramps.

¹ The length and breadth of the coffers of the ceiling of the peristyles 3.5 respectively, measured from centre to centre, in front of the Pronaos and Posticum seem to have been about 3.7 and ² On the smaller coffer traces of a honeysuckle were visible.

The bars of which these are formed are let into the tympanum flatwise, but are twisted so as to have their breadth vertical in their insertion into the backing wall, thereby obtaining great stiffness.

The door jambs have a very delicate inclination, sufficient only to counteract any optical illusion tending to make the opening appear wider at the top than at the bottom, which might have occurred had these jambs been perpendicular. The jambs were probably cased with bronze, fixed on wooden framing, for which a shallow sinking or rebate is provided.

The plumbs, which are measured from an imaginary straight line towards the letters AA, show that each of the door jambs is inclined .114 in a height of 33 feet. The wall of the Posticum, which for convenience is referred to the same line, towards the letters BB, is shown to be perpendicular. The stones forming the lintel over the door are the longest of all the blocks of Pentelic marble remaining at Athens. The scantling of one of them is 25.62 feet $\times$ 3.43 by not less than 2.60 in thickness.¹ There are evident traces of the metal railing which enclosed the Posticum, a little within the centre of the columns, and returning against the antæ. It was supported by a low step or podium which was let into the basis of the columns. Signs of a similar railing may be traced between the columns of the Pronaos. Compare Plate IV.

In the middle of Plate XVII., containing isometrical views of the south-west angle of the roof, the parts above the cornice are shown almost exactly in their present state.² In the two representations at the bottom of the plate the superior courses are supposed to be lifted off. The construction of these beds and joints has been entirely laid open by a fracture which has taken place at the north-east angle. Above, on the right hand, is given a section through the lion's head (this is taken from the north-west angle of the temple). The lion's head is worked out of a block which forms the springing stone both of the cymatium and the corona of the pediment. Upon it was placed the "head-stone of the corner," which covered and overlapped this and seven other tiles. This stone seems not to have been connected by means of studs or cramps with the courses beneath it. The shallow rectangular trough, which is sunk into its upper surface, received the base of the sculptured ornament or figure which adorned the angle acroterium.

At the top of the plate is a restoration of the tiling of the roof at the angle, composed from the authorities above-mentioned, and from remains of the tiles themselves, which are also given on a larger scale.³ The small saddle tile marked C, which appears to have belonged to the Parthenon, suggests the way in which the ridge of the roof was probably finished, but the ridge, as in the Temple of Nemesis at Rhamnus and in some other Greek temples, was often crowned by a line of antefixæ (see the *Unedited Antiquities* and Mr. Cockerell's work on the temples of Ægina and Bassæ).

Sufficient traces of the tiling remain on the south-west and north-west angles to point out clearly the arrangement. There is a trifling irregularity in the width of the course nearest the acroterium, but the measurements of the others show that three courses of tiles correspond to two intervals between the antefixæ; and one of the latter was placed over every mutule. The appearance of the angle seen from below is shown in Plate I.

Plate XVIII. shows the traces left upon the upper bed of the horizontal cornice of the sculptures which once adorned the western pediment, of which one group alone, unfortunately much mutilated, now remains *in situ*. There are some marks on the vertical face of the tympanum not here recorded; but what seems to be interesting in relation to the sculptures, is a number of shallow sinkings let into the cornice,

¹ This lintel had been injured by fire, and, in consequence of its dangerous state, has recently been replaced by an arch.

² The only difference is that a few additional particulars are given of the tiling, gathered from the north-east angle. The back part of one of the stones forming the cornice over the pediment was cracked at the time of the building of the temple, and was cramped together in the manner here shown. The two nearly square sinkings which appear in the middle of the great stone at the angle of the horizontal cornice, pass through the whole block, and were evidently intended for lifting it, probably by means of ropes, for which provision seems to be made. The long shallow sinking, of which part has been filled up by a small piece of stone entirely separate from the great block, is less easily explained. It may be seen at the corners of the ætoi, but it can scarcely have had any purpose connected with fixing the sculptures. Can it possibly have been intended to act in some manner, not afterwards carried out, in keying the upper courses into the lower? The fact that it is found at each of the angles of the building, would render any such change of purpose, which we might admit in a single instance, the less probable. Or can it have been done with a view to

lighten, in some degree, the overhanging parts of this stone? The small piece which fills up part of the trough may have been found necessary when the upper course was fixed, which carries the lion's head.

³ The subject of the tiling of the Greek temples has been well and clearly treated in the *Unedited Antiquities of Attica* and in Wilkins's *Pro-lusiones Architectonicae*.

The tiles of the Parthenon (and I believe of the Greek temples generally) were formed of Parian marble. As this material does not seem to stand the weather so well as the Pentelic, the question occurs why it should have been used for this purpose at Athens. Was it more economical to import roofing tiles from an established manufactory at the Parian quarries than to work them on the spot from the material of the neighbourhood? Or may we suppose that the remarkably transparent quality of the Parian marble led to its adoption? for we may readily believe that sufficient light would be refracted through these tiles to light the void space between the external roof and the ceiling, or even to aid in some degree in lighting the naos of a temple, which had no hypæthral apertures, or where these were small.

and carried under the tympanum, where corresponding openings are provided, rising a little above the bed of the cornice. All these parts were strongly marked with the oxide of iron, and there can be no doubt that they were intended for the insertion of iron brackets or cantalivers, for the purpose of relieving the cornice from the weight of the heavier groups of sculpture.

The central portion of the sculptures of the eastern pediment was (as is shown on the plate) supported in part by similar cantalivers. It would seem from their disposition that the chief mass of the group immediately connected with the figure of Jupiter was placed a little to the left of the centre of the pediment. Some of the holes on these blocks were made for the purpose of lifting them by means of the instrument called the forceps or lifting shears, the "forfices ferrei" of Vitruvius (X. 2).

CHAPTER VII

ON THE CURVES OF THE ATHENIAN MOULDINGS

SEE PLATES XIX. XX. XXI.

NEXT in importance to the extensive horizontal curvatures of the stylobate and entablature, and the vertical entasis of the columns, the various forms of the mouldings of the principal ancient buildings of Athens claim our attention. It is owing to the perfection of these, both in design and execution, occupying, as they do, an intermediate position between the ornamental sculptures of the frieze and pediment and the simple lines of the architecture, that the Doric structures produce on the mind a sufficient feeling of richness, so admirably chastened as not to interfere with their reserved and almost severe majesty.

In the three plates above-mentioned the figures are all one-third of the full size; and the different forms of profile which occur among them may be classified in the following manner—

I. Simple convex mouldings, *i.e.* those of which the section or profile is convex, as the echinus of the Doric capital.

II. Simple concave mouldings, such as the flutes of the columns.

III. Simple mouldings produced by curves of contrary flexure, which are convex in one part and concave in another, the moulded part being continuous and not interrupted by cusps or fillets.

IV. Compound mouldings which are made up of two or more of the former, separated by fillets or cusps; such as the bases of the Ionic columns and the capitals of the Doric antæ.

CONVEX MOULDINGS.

The following may be reckoned among those of the first kind.

Fig. 1 is the echinus of the capitals of the columns of the peristyle of the Parthenon; it is taken from a well preserved specimen from the south-east column.¹

This profile from A to E is composed of segments of three different curves, the upper part A P is produced by an hyperbola, of which the centre C is pointed out by the face of the abacus produced, viz. B O C.

The line of the principal axis X X is very nearly parallel to the underside of the abacus. This curve at the point P merges into a portion of a circle P E, of which the radius is about 10 feet, which happens to be just the radius of curvature at P.

The small portion of the echinus above A coincides with the osculating circle² at the point A. The upper point of the annulets, L, lies in the hyperbola A P above-mentioned.³

¹ All the profiles obtained from well preserved capitals were found to be almost identical in their curvature. It seems most likely that the capitals of the columns of the Parthenon, Propylea, and Theseum were turned in lathes. There can be no doubt that the mechanical contrivances necessary to effect this were not too difficult for the ancients, although the stones out of which the capitals were formed weighed upwards of three tons. Pliny expressly tells us that the columns which were used in a building connected with the Labyrinth of Lemnos, which must have been erected considerably earlier than the Parthenon, were remarkable for having been

turned in lathes. Lemnius (sc. Labyrinthus) similis illis, columnis tantum centum quinquaginta mirabilior fuit, quarum in officina turbines ita librati pependerunt, ut puero circumagente tornarentur. *Hist. Nat.*, Lib. XXXVI. —19. These were probably monolith shafts, and no doubt weighed much more than the capitals of the Parthenon columns.

² For the meaning of this term, see Appendix, Art. 8.

³ In this figure, C A the principal axis of the hyperbola A P L is exactly one dactyl, = $\frac{1}{8}$ Attic foot; the eccentricity which determines the shape of the curve, usually denoted in mathematical books by the letter e (see

If we follow the curve of the capital downwards as far as the necking $Y, F A' G$, is another hyperbolic arc, of which the centre is at C' , $X' X'$ being the line in which its principal axis $A' C'$ lies. This hyperbolic arc unites at a common tangent at the point G , a little above the neck, with the great hyperbolic arc which forms the entasis of the columns (see Chap. V. p. 40), so that the contour of the whole column sweeps from the ground in three hyperbolic arcs; one from the pavement to the point G , convex, another from G to a point between F and L , concave, a third from thence to the abacus, convex. All the departures from these bounding curves,¹ at the necking, the annulets, between E and P , and above A , are mere architectural treatments, such for instance as the flutes in a circular column, or the annulets ($\rho\acute{\alpha}\beta\delta\omicron\iota$) in the Ionic base of the Erechtheum; and we may consider the bounding outline of the capital to be composed of a cyma reversa produced by two hyperbolic curves. In the case of Fig. 1 (see Plate XIX.), I have subjoined a table comparing the actual with the theoretical curve; and in the examples from other buildings I have given sufficient measurements for any one so disposed to make the trial with the hyperbolic elements which I have determined.²

One point, in which these Athenian examples of the Doric echinus differ from the more usual form, is that the abacus projects a little over the echinus. The length (CA) of this projection when obtained accurately (by averaging a sufficient number of examples) is found to be exactly that of the principal semi-axis of the hyperbola forming the echinus of the capital; and I think that we may feel satisfied that it was so left by these scientific architects as a testimony of perhaps one of the earliest solutions of the properties of the conic sections, namely the determination of the centre of the curve.³

Fig. 2, which is placed near the former, is an example from one of the fallen capitals from the southern peristyle. The width of the abacus in these, as I have already remarked (Chap. II. p. 15), is considerably less than in the eastern or northern capitals. The appearance of the echinus of some of these on the south side suggests the idea that part, at any rate, of the amount of this reduction was made after some or all of the capitals were worked; for (as in this example) the more convex part of the echinus, as shown by the dotted line, is cut off, in order apparently to reduce the spread of the capital. This would have affected its entire breadth about .036, no insignificant matter in the eye of a Greek.

Fig. 3 is from a fallen capital of the Pronaos; this is a segment of an hyperbola, and is identical in its curvature with Fig. 1, except that the same curve (the curve APL in Fig. 1) is continued throughout the whole length of the surface, viz. from A to E ; consequently the lower part of this echinus is a flatter curve than that of the peristyles.

The projecting points of the annulets lie here in the curve which forms the Epitrachelium, and these two curves do not die into each other, as in the case of the peristyle.

Fig. 4 is from the column of the larger order of the Propylæa. This example is also hyperbolic, and we find the centre C here also pointed out by the face of the abacus BO produced. The principal

Appendix, Art. 5) is equal to $\frac{3}{2}$; and it is remarkable that in all the hyperbolic arcs connected with these mouldings which I have investigated, this ratio has always a simple manageable value. Thus, in the echinus of the Parthenon and of the Theseum $e:1 = 3:2$. In the epitrachelium of the Parthenon (the curve $GA'F$ in Fig. 1), $e:1 = 3:1$. In the echinus of the Propylæa both in the large and small orders $e:1 = \sqrt{2}:1$, a ratio easily constructed geometrically. In the soffit of the pediments of the Parthenon $e = \frac{3}{2}$. In that of the Propylæa $e = 2$. Now (although I do not deny that these curves may possibly have been drawn by a mechanical apparatus) since all these ratios are easily constructed, it follows that by the well known method of focus and directrix (see Appendix, Art. 5), the curve might have been easily laid down by points.

¹ The late Mr. Jopling, who bestowed very great attention on the subject of curved lines in architecture, and whose discoveries in the construction of mechanical curves deserve to be extensively known, contends, in a letter read to the Institute of British Architects, Feb. 21, 1848, that the contour of the echinus of the columns of the Parthenon is produced by one of the forms of the conchoid of Nicomedes (see Appendix, Art. 3), a curve of great variety and beauty, and which has the advantage of being of somewhat easier construction than the hyperbola. If we were bound to find a single curve to fit the moulding from A to E (instead of touching the point L), a conchoid might probably be found which would approximate more nearly than any single hyperbola which could be drawn between these points. But still the coincidence of the conchoid would be by no means complete. Moreover the echinus of the columns of the Pronaos (Fig. 3) is a simple hyperbola along its whole section from A to E , and there are several other cases of the use of the hyperbola, such of the curve $GA'F$

(Fig. 1), which cannot be conchoidal. These proofs, together with the evidences of selection which I have already pointed out in the elements of the curves, and the exceeding accuracy of the coincidences, so far as I claim them, are sufficient proofs that the curves in question are hyperbolic. Yet it is not unlikely that other examples, especially in the forms of vases, may be found, which may justify the belief that the Athenian architects were acquainted with the conchoid. It is true that this curve is mentioned by the writers on the geometry of the ancients, as having been discovered about two centuries later than the period of which we are speaking; but the same authorities also attribute the invention of the conic sections to the school of Plato, of which curves some instances can be shown to have been used in the time of Pericles, and indeed much earlier.

² The profiles given in these plates were obtained by the aid of Professor Willis's cymagraph, an instrument somewhat resembling the pantograph. In the instances here given, the process has been in every case reversed in the same instrument, in order to eliminate the small errors, to which it occasionally is liable in certain parts of its operation.—These errors, however, it should be stated are so extremely slight as to be unimportant in ordinary cases. The larger curves, as Figs. 10, 11, etc., were taken partly by the cymagraph and partly by other methods.

³ I have already observed, in a note in Chap. V. p. 40, that there is reason to believe that the curve we are here speaking of was used in the earliest Greek temples. But as one of its branches might have been drawn by means of the focus and directrix, without it being at all necessary that the centre should be known, it is very interesting to find this proof of progress in the science of mathematics recorded in the works of the architect. Comp. Appendix, Art. 5.

axis is one dactyl; the eccentricity (or ratio e) as $\sqrt{2:1}$; and the line XX considerably inclined to the soffit of the abacus. The hyperbolic curve extends from A to P . From P to E it seems to be a straight line.¹ The part above A is made to coincide with the osculating circle at A , as in the case of the Parthenon, and by this means a rather more decided line is produced under the abacus than would have resulted from the hyperbola, had it been allowed to take its own course.

Fig. 5 is from the column of the smaller order of the Propylæa. The hyperbolic axis, called a , equals .044 foot, or $\frac{7}{160}$ of a dactyl, which thus bears exactly the same ratio to that of the larger order as the diameter of the column and other architectural members of the two orders bear to each other. The centre of the hyperbola here also lies in the line BO produced. In this case the hyperbolic curve extends from the abacus to P , differing in this one particular from the former examples, namely that the portion of the curve above A is hyperbolic instead of circular. The circle of curvature at P , of which the radius = 8.5 feet, forms the remainder of the surface from P to E .

Fig. 6 is the section of the echinus of the capitals of the Temple of Theseus; this coincides with an hyperbolic arc through nearly its whole length, viz. from the abacus to P . The remainder PE is so short a line that its nature is indeterminate. This example is the most completely hyperbolic of all the capitals, not even excepting those of the inner order of the Parthenon; it seems to have been thought a little too flat, and the curve was afterwards slightly modified in the Periclean buildings. In this example $e = \frac{3}{2}$, and CA the principal axis = .04, and, as in the former instances, is exactly pointed out by the line BO produced. The line of the principal axis, XX , makes a very slight angle with the soffit of the abacus.

Another simple convex moulding is Fig. 7 (see Plate XX.), viz. the cymatium of the Parthenon, which is a portion of a circle. This, I believe, is the only instance in the Doric structures of the best period of a convex moulding of which the section is circular. And it is not unlikely that no other curve could have been so fitly chosen for this particular situation, as, although the circle may appear comparatively monotonous in composition, owing perhaps to a tendency to return into itself instead of suggesting sequence or flow of line, it may yet, for the very same cause, be the most fitting to be used singly, and we cannot doubt that it was most happily chosen for the finishing member of the very highly artistic and well studied building which it crowns.

The cymatium of the Propylæa appears to be an ellipse of very small eccentricity (see Plate XXXI.) That of the Temple of Theseus is given in Plate XXXV. The section of this moulding also is for the most part circular, but it differs from that of the Parthenon in having a little contrast in the curvature of the lower part.

Lastly, Figs. 8 and 9 (Plate XX.) are respectively the ovolo mouldings which finish the marble beams supporting the coffers of the ceiling² of the peristyle and posticum of the Parthenon. These are placed in their proper positions relative to the strings, etc., underneath them, and will serve further to illustrate the plan and section of the ceiling, Plates XV. and XVI.

CONCAVE MOULDINGS.

Of these by far the most important are found in the soffits of the coronas of the pediments.

That of the Parthenon, Fig. 10 (see Plate XIX.) is produced by an hyperbola, of which the principal axis is .2535 foot, or one Greek palm. The constant ratio e is $\frac{3}{2}$. The line of the principal axis, CS (where C is the centre and S the focus, see Appendix, Art. 5) makes an angle of about 30° with the face of the corona. The comparisons between the measurement of the moulding and the mathematical curve are given in a table on the plate. The quiet and delicate gradation of shade on the moulding, resulting from this marvellous exactness of execution, must have contrasted beautifully with the vigorous lines of the sculptures on the pediment to which it served as a background.

Fig. 11, the similar moulding from the Propylæa, differs but slightly from that of the Parthenon.

¹ It does not in this respect differ from the other examples, where the portions below P are parts of large circles, as the radius of curvature of the hyperbola at the point P in this case would be 54 feet, and the difference between a straight line and a circle having that radius would in so short a distance be quite imperceptible.

² For those belonging to the ceiling of the Propylæa, see Plate XXIV.

The principal axis, a , = .1267, or two dactyls. The constant ratio, e , = 2 : 1. The line of the principal axis, CS , makes an angle of about 45° with the face of the corona, or rather 45° exactly with the line of the bed BB' . In another table on the same plate will be found a comparison between the measurements and the mathematical curve.

Fig. 12, the soffit of the corona of the Theseum is a portion of a parabola, whose axis AS is .0375 foot.¹ The axial line XOS makes an angle of $\frac{1}{4}$ of a right angle with OB the joint or bed-line. $OA = AS$; so that the directrix passes through the point O , which lies in the face of the corona CO .

Fig. 13 is the corresponding moulding from the main cornice of the Erechtheum.² This is also parabolic, the axis AS being one dactyl. Here the focus is pointed out by the straight line LSB ; and the axial line AX makes with it an angle of about $\frac{1}{4}$ of a right angle.³

Next to the above the principal concave mouldings are the flutes of the columns, of which Figs. 14, 15, 16, and 17 (see Plate XXI.) are instances. These are invariably formed by arcs of circles and are therefore portions of what are called false ellipses.⁴

In these examples (see Fig. 14) the chord of the flute FF' is divided into a definite number of equal parts. The middle part of the flute MM' is usually described from a centre C , determined by an equilateral triangle FCF' , and the portions MF , etc., about the cusps are formed by circles of which the centres are marked C_1 , the radii being generally about half or one third of CM . The point where the straight line joining the centres of the larger and smaller circles intersects the chord of the flute is found to be one of the above-mentioned definite sub-divisions of FF' .

Fig. 14 is from the peristyle of the Parthenon, and the flute is similar to this in every part of the column except in the upper drum, where at the neck it takes the form given Fig. 15, in which the sagitta SA is about a sixth part deeper in proportion to the breadth FF' , so that the flutes have sharper cusps. This form changes into the other in the height of the upper stone an average length of about 2.8 feet.

The delicate and beautiful effect of cast shadow and increased richness of moulding produced by this artifice (which, at Athens at least, is peculiar to the Parthenon),⁵ in that part of the column where the effect of the deep background of shade fully compensates for whatever breadth of light is lost by the deeper sinking of the channels, is extremely happy, and prepares the eye for the more intricate play of light and shade in the capital and entablature.

Fig. 15 (*a*) is an elevation of the necking of the lower part of the capital, showing the curve by which the fillets of the flutes fall into the lowest of the annulets. The fillet at the neck is about .006 wide, and is proportionally increased to .0075 at the base of the column.

Fig. 16 is a section of the flute of the columns of the Pronaos of the Parthenon. This differs a little from that of the peristyle, in that the length of the sagitta SA , which there is only indirectly obtained from the chord, is here first determined, and is equal to $\frac{1}{3} FA$. The chord FF' is then

¹ The quantity .375 is a common measure of the Theseum.

² That of the northern portico scarcely differs from this.

³ These four fine concave mouldings are worked with such precision that when the measurements were carefully laid down upon paper, the above-mentioned elements were immediately indicated by the method of the bisection of parallel chords (see Appendix, Art. 5) and on reconstructing the curves mathematically with the elements so suggested, they were found in each case to be identical with the section of the actual moulding. The curves of the capitals were not so immediately detected. I have shown that in some of them portions of circles are used in combination with the hyperbolic forms. This rendered the first results less satisfactory; but, finding each approximation sufficiently near to justify a new trial, I succeeded in completely resolving the figures into the elements which I have assigned to them.

⁴ These curves are best obtained in the Parthenon just above or below the jointing of the stones. The templet or mould, which the workmen used in shaping the flutes, seems to have been generally applied at every bed-joint, and the intermediate space worked straight from one joint to another. In the Erechtheum, where the stones are much longer in proportion to the height of the column, it must have been used in the middle of each stone as well as at the bed-joints, for in this temple the curve of the entasis is perceptible between the joints, which is not the case in the Parthenon.

I examined very carefully all the forms of flutes in the Periclean buildings,

expecting to find among them regular ellipses; but it need not surprise us that, for the purpose we are describing, the Greek architects, notwithstanding their love for mathematical curves, adopted an approximate instead of a true ellipse; because as the flutes diminish with the columns, the mould or templet would require to be altered continually to suit the varying breadth of the flutes, in order to produce everywhere that similarity of figure which is the characteristic of the flutes of the Greek buildings of the best period. For by whatever means an ellipse is to be constructed mechanically, it is a work of time so to arrange the foci, etc., as to produce an ellipse of any exact length and breadth which may be desired, and it usually requires more or less tentative adaptation. The approximate method by circles secures the end at once, and although the Greek architects seem usually to have preferred regular figures, yet in this case, where, in the height of every column (for the joints not being of the same height every column would want a different set of templets—see previous note), the mould requires to be varied eleven or more times, we need not wonder at their adopting a method which so much facilitated their proceedings, especially as, generally speaking, perfection of contour is of less importance in a concave than in a convex moulding.

⁵ In the Theseum and the Propylæa at Athens the flutes do not vary throughout their whole length; at Eleusis, Sunium, Ægina, and some other instances, they appear to be shallower at the top than at the bottom. In a Doric Portico at Cnidus, given in the 3d vol. of the *Ionian Antiquities*, published by the Society of Dilettanti, the flutes in this particular resemble those of the Parthenon.

divided into eight equal parts, in order to determine the line CL , the common normal to the larger and smaller circles. CLL' is an equilateral triangle whose base $LL' = \frac{3}{4} FF'$. The rest of the construction is explained on the figure. The fillet is about .006 wide at the base of the column.

In the Propylæa the flutes of both orders of Doric columns are produced by single segments of circles, the radii of which equal the breadth of the flutes.

The flutes of the Ionic order are given in Plate XXXII. The sagitta $SA = \frac{1}{4} FF'$ measured from centre to centre of the flutes. The larger radius $= SA + ST$. The smaller radii $= SA$. The point of intersection D , of the common normal with the chord, bisects ST . The fillet TT is $\frac{1}{8} FF'$.

Fig. 17, the Ionic flute of the Erechtheum (returning to Plate XXI.) is rather more complicated. It is drawn by means of four centres. The sagitta is $\frac{1}{3} FF'$. The centre which forms the edges of the flutes is determined by the intersection of the lines FC_1 and F_1C_1 which are tangents at F , and F' of the circle formed by the plan of the column. The second centre C_2 which forms the middle part of the flute, is distant $\frac{3}{4} FF'$ from A . Lastly, there are two smaller circles described on centres C_3 and C_4 , interposed between the other two segments in order to make the curve continuous. The fillet is very narrow, not exceeding $\frac{1}{16}$ of the breadth of the flute FF' .

The flute of the lower drums of the Temple of Theseus is given on a large scale by Stuart,¹ but the flute should be divided into four parts instead of five, to determine the position of the common normal, and the principal radius should be $\frac{5}{4}$, and the smaller $\frac{3}{8}$ of the chord. The sagitta being $\frac{1}{4}$ of the chord, these flutes have a very narrow fillet not exceeding .003.

The remaining simple concave mouldings are the stillicidium of the cornice of the Parthenon (Fig. 18 Plate XX.), and that of the Propylæa, for which see Plate XXXI.

Figs. 19, 20, 22, and 23 are respectively the section of the head of the central channels and the plan and side and front elevations of the ordinary triglyphs of the Parthenon. In these the head simply grows or gathers out of the chamfered side of the triglyph; those at each of the four angles of the temple, of which the plan is given in Fig. 21,² are more elegant. The form resembles in some degree a miniature Gothic vault.

MOULDINGS OF CONTRARY FLEXURE.

To this class belong Fig. 24 see (Plate XIX.), the talon moulding above the corona of the pediment; and Fig. 25, the hawksbeak drip moulding above the horizontal cornice of the Parthenon. In the Propylæa the same moulding (Fig. 26) was applied both to the raking and to the horizontal cornice.

Figs. 27 and 27^a (Plate XX.) show the upper and lower moulding of the painted band under the beams of the ceiling of the peristyle. This is also given in Plate XXIII. This moulding is a perfect masterpiece of design, and perhaps it would be impossible to depart in the slightest degree from the lines actually adopted without impairing its beauty.

Fig. 28 is the upper moulding of the similar member from the Posticum.³

Figs. 29 and 30, Plate XIX., the smaller mouldings of the cornice of the pediments of the Theseum.

Fig. 31, Plate XXI., is the moulding which ran at the bottom of the small step or podium which extended between the columns of the Pronaos and Posticum of the Parthenon, and which supported the metal rail or fence between the columns.⁴

Figs. 32 and 33, though rather more complicated, may be grouped in this class. They form respectively the bed mouldings of the cornice of the pediments of the Parthenon and Propylæa. It will be noticed that notwithstanding the greater projection of the cornice, which it is designed to

¹ 2d. edition, vol. iii. Plate XII.

² Mr. Donaldson (see 2d edition of Stuart, vol. iv. page 12), seems not to have been fortunate enough to find any perfect example of the pendant termination shown in Fig. 23. Going carefully round the eastern front, I met with one or two specimens from which it might have been restored with some degree of accuracy, but none which could be perfectly relied on, except that at the south-west angle.

³ The under cutting of the moulding No. 28 is in some parts not

complete, and this is one of the signs, of which there are several, that those political troubles, which caused the Erechtheum to remain a long time in so unfinished a state, had begun before the last touches were given to the Parthenon; and it furnishes another proof that these mouldings were not worked until the structure of the temple was completed.

⁴ I was indebted to Mr. Cockerell for this specimen. There are now no actual remains of the moulding, although its trace against the column and antæ is still visible.

support, the former is much the more delicate of the two. This difference of character very much pervades the two buildings.¹

Fig. 34 is the base moulding which supports the orthostatæ, or slabs forming the lower course of the cella wall of the Theseum, peculiar, at Athens, to that temple. This is a fine specimen of a moulding of contrasted curvature.

Fig. 35, with the plan connected with it, is taken from the pedestal inscribed to Minerva Hygieia. There are marks upon it which seem to show that it was the base of a statue. It is placed just outside the eastern portico of the Propylæa (see ground-plan Plate XXVII.). The top of the nearly semicircular plinth on which it stands is continuous with the upper edge of the stylobate. The mouldings are delicate and beautiful; the story which connects it with the history of the building of the Propylæa is given in Leake's *Topography of Athens*.²

COMPOUND MOULDINGS.

Fig. 36, Plate XX., is the section of the capital of the antæ of the Posticum of the Parthenon. The Doric hawkbeak moulding was most frequently used, as here, in situations in which the light was reflected from below, for which its contour is peculiarly fit. We should also observe the inclination forwards of the corona or fascia above it, by which it would not only be more fully illuminated by light reflected upwards than if it were perpendicular, but it also subtends a greater angle to the eye of a spectator standing in the narrow peristyle.

Fig. 37, Plate XXI., is the capital of one of the antæ of the Temple of Theseus taken at the west end. The fascia here is perpendicular, but as the space in the porticoes in which these antæ are placed is less confined than in the Parthenon, the reasons which led to the adoption of the peculiarity above mentioned, and which also is found in the antæ capitals of the Propylæa, had not perhaps suggested themselves.

I have now given all the mouldings which are to be found in the Parthenon. Those which remain to be noticed are Figs. 39 and 40, the bases of the columns of the northern and eastern porticoes of the Erechtheum; and 41, the group of mouldings forming the basis of the Choric monument of Lysicrates.

In these mouldings, excepting the last-mentioned, circles and combinations of circles are pretty freely used. My inducement to give them is that the apophysis of these columns has not been well given by Stuart, as a very observant traveller has remarked.³ This beautiful feature, considered in itself, is certainly an advance in art beyond the severity of the Doric shaft, which appears to adhere closely to its type, the felled trunk (adopting the Vitruvian derivation), whereas the growth of the shaft of an Ionic column from its base resembles more a young and living tree.

Before quitting the subject of mouldings, it may be worth while to remark the wonderful variety of light and shade which is produced by them, and especially by the simple Doric mouldings. This is in a great measure owing to the curves selected being hyperbolic or parabolic, with small axes, and therefore having great variety in their curvature (see Appendix, Art. 13). I would particularly remark the echinus of the capitals and the soffit of the cornices of the pediments, in all of which the curvature, at first very quick, becomes in a short distance exceedingly flat, so that all varieties of light and shade are produced in a continuous surface and in the simplest manner.

¹ Almost all the mouldings in the Propylæa are bolder than those of the Parthenon. (Compare, for instance, Fig. 18, Plate XX., with the similar moulding given in Plate XXXI.); and the inclinations from or towards the perpendicular in certain parts of the architecture already described, are generally more considerable.

This difference of character may probably be referred to the individual tastes of Mnesicles and Ictinus, or perhaps may rather be supposed to be due to the superintending eye of Phidias in the Parthenon, as in Ictinus's own temple at Bassæ there is by no means so extraordinary a degree of refinement; although, on the other hand, we may allow that a different

treatment might properly be looked for amidst the wild scenery of Mount Cetylum to that which was required for the Athenian Acropolis.

² 2d edition, pp. 145 and 630.

³ *Letters of an Architect*, by Mr. Joseph Woods, before cited, vol. ii. p. 254. The same author (vol. i. p. 337) makes some valuable observations on the subject of the apophysis of columns, when speaking of the temple known by the name of Jupiter Stator in the Campo Vaccino at Rome. I should, however, observe that there are not wanting examples of actual buildings in London where the apophysis has been exceedingly well given. St. Pancras Church, by the late Mr. Inwood, may be cited as one of the best instances.

It would be impossible to convey in words any idea of the beauty of the distinct shadow cast by the square abacus upon the swelling echinus, the surface of which is in many instances scarcely less perfect than when it left the workman's hands.

The reader may be referred to numerous examples of the application of geometric curves to the mouldings of the Athenian buildings in Mr. Pennethorne's work, already cited.

CHAPTER VIII

ON THE POLYCHROMY OF THE PARTHENON

PLATES I. XXII. XXIII.

IN taking the measurements necessary to determine the curvatures and other delicate adjustments of the Parthenon, it was impossible not to be attracted by the evident though generally faint traces of ancient colouring which occasionally met the eye; but as the subject of Polychromy does not form a principal object of this work, I shall, in referring to it, confine myself almost entirely to a statement of the observed facts.

There are several traces of mediæval painting on the cella walls, which have led some persons to imagine that all the colour found on the temple belongs to a period subsequent to its erection. But after attentive examination, the bad drawing and poverty of material in the mediæval portions above mentioned become so evident, and such fitness of design and excellence of material and execution in the ornaments which I am about to describe, that it is impossible to resist the conclusion, not only that the latter are ancient Greek paintings, but that they are coeval with the building of the temple.

In Plate XXII. are given the traces of a painted ornament, and some miscellaneous details connected with marks remaining on the architrave; of these last little can be said beyond what is recorded in the plate itself. (Compare also Plates VII. and VIII.)

On the eastern front inscriptions were placed between the shields, of which the irregular marks here given are the sole remains. In one or two places thin laminae of bronze are still attached, projecting slightly out of the holes.

The fret and honeysuckle ornament here given were painted on the tænia, or architrave band, and guttæ tablets respectively. The design of the first could be distinctly traced in several places; of the second only a single instance, under the south-west angle triglyph towards the west, has been preserved. Of the colour once applied to these ornaments there are no remains, but the marble under the ornament has been better preserved than the adjoining parts by the pigment, so that it is at present distinguished by its more even surface. In many places the original setting out lines remain, supplying sufficient authority for the restoration here given.

In the lithotint, Plate I., are given in chiaro oscuro all the parts of the external architecture on which evidence of painted ornaments or colour has been remarked. It is at least doubtful whether the abacus or echinus, or any other parts, except those shown on this plate, were covered with fret work, flowers, or other patterns; for the clear incised line which seems invariably to have formed the outline of these ornaments, and which still remains on some of the most exposed mouldings, is I believe confined to the portions here represented as enriched. How far the plain surfaces of the corona, architrave, and columns were painted in flat colour must probably remain a matter of conjecture; there seems, however, some slight ground of evidence that a peculiar yellow tinge upon some parts of the columns, especially of the west front, is not simply the yellow said to result from the oxidization of iron contained in the Pentelic marble, but has been applied externally as a tint, though perhaps so delicately as merely to reduce the high light of the marble when new, without greatly obscuring its crystalline lustre.¹

¹ It would be unreasonable to suppose that the ancients entirely concealed, or even materially altered in appearance, the general surfaces of the marble (*Λείοκος λίθος*) which they made a great point of obtaining whenever possible; but no one who has witnessed the painfully dazzling effect of

The architrave, corona, and perhaps the sculpture may have been treated in a similar way.

The cymatium was adorned with a row of honeysuckles surrounded by a figure, oval at the top, and dividing itself into double scrolls at the bottom; the traces of these were sufficiently evident, but those of the intermediate leaf between the honeysuckles were so faint that it was impossible to decide the exact number of its divisions. The restoration given in the figure on the left hand upper corner of the plate was taken from a painting on a cymatium of terra-cotta preserved in the Acropolis, in which the other parts of the decoration are very similar. No remains of colour were found on the cymatium.

On the right hand upper corner of Plate I. are given the figures which adorned the talon and hawksbeak mouldings, which occur above the coronas of the raking and horizontal cornices respectively. The former in its developed form, as shown in outline at the top of the plate, is of a heart-shape, and receives a very elegant modification from the form of the ogee moulding upon which it is applied. On the lower part of this moulding some faint traces of blue and red were to be seen. The hawksbeak moulding is adorned with a pattern of very usual occurrence in Greek Doric, and which bears a considerable resemblance to certain forms of Egyptian ornament. There were some faint traces of blue in the lower part of this moulding. The bed-mould of the raking cornice of the pediments, of which the section is given in Plate XIX. Fig. 32, is ornamented with a figure similar to the last. There seemed to be on this moulding no positive vestiges of colour, but some indications leading to the belief that in its painting it was similar to the pattern on the hawksbeak mouldings in Plate XXIII. On the narrow fillet below was a distinct trace of verdigris green.

The mutules afforded the next evidence of colour. Their edges and soffits were painted deep blue, of which colour there were undoubted remains about the middle of the east front. The soffits and vertical spaces of the divisions between the mutules were unmistakably red, which colour extended also in a narrow fillet underneath the mutules. No trace of colour was seen on the guttæ.¹ The soffit of the cornice between the mutules at the angles of the building was adorned with painted figures, composed of honeysuckles connected by scrolls, which seemed to be different at the four angles of the temple.²

The labyrinth fret beneath the mutules, with the exception of the upper fillet above mentioned, showed no trace of colour, though the design was as distinct as the figure on the plate; underneath it, in the narrow soffit which occurs above the metopes, red colour was visible.

Inside the channels of the triglyphs of the eastern front, very positive and well preserved portions of blue were to be found, and other (but fainter) traces on the face above the triglyphs.³ The pigment seems to have been about .0025 in thickness, of an uniform nature throughout.

There are very slight remains of colour, if any, on the sculptures. I am not aware of any except a slight trace, which, however, appeared to me of rather a doubtful character, on a metope which had been recently disinterred, and now preserved on the Acropolis; and some authorities have supposed a blue background behind the sculptures of the Panathenaic frieze. But on this point positive assertions are not justified in the absence of remains.

The fret on the architrave band, and the honeysuckle ornament on the guttæ tablets, have been already described in the preceding page.

Plate XXIII. refers to the capital of the antæ of the Posticum of the Parthenon.

As the capital of one of the northern antæ given in the plate has preserved considerable traces of colour, some restoration has here been attempted. In the upper example, with the exception of the

fresh Pentelic marble under an Athenian sun, will deny the artistic value of toning down the almost pure white of its polished surface, and the more so, when some portions of the architecture were painted in strong positive colours.

We need not suppose this tone to have produced more than the difference between fresh white marble and ivory. We learn from Pliny (*Hist. Nat.* XXXVI. 23) that milk and saffron mixed with the lime were used to produce a delicate colour in frescoes. And Plutarch (*Themist.* 8) speaks of certain monumental marbles in Eubœa which presented, when rubbed, the smell and even the colour of saffron. Or we may perhaps suppose that the ochre of Mt. Laurium was used. Of which Vitruvius says (VII. 7), "Itaque antiqui egregiâ copia silis ad politionem operum sunt usi," etc.

¹ Compare the guttæ of the Propylæa, Plate XXXI. A poros stone fragment lately found on the Acropolis has the guttæ inserted in white stone.

² In the north-west angle represented in Plate I., this pattern has been

less perfectly preserved than elsewhere. A beautiful variety from one of the other angles is given by Mons. Paccard in the great work commenced under the superintendence of the Comte Laborde, entitled, *Parthenon, Documents pour servir à une Restauration*, Paris, 1847. It is much to be regretted that this valuable work has been discontinued.

The ornament we are describing is incorrectly represented as sculptured in the Parthenon by Stuart, Plate IX. Fig. 3. At Segeste, however, and perhaps some other temples, it was sculptured.

³ Similar traces of blue were observed on the triglyphs and mutules of the Theseum. The remains of the Temple of Jupiter Panhellenius in Ægina give similar evidence, but much more distinctly. (See *Expédition Scientifique de Morée*, and page 27 of Mr. Cockerell's beautiful work on this temple.) The presence of the blue on the triglyphs illustrates the following passage of Vitruvius (IV. 2), "Antiqui eas (tabellas contra tignorum præcisiones in fronte fixas) cera cærulea depinxerunt, uti præcisiones tignorum tectæ non offenderent visum."

gilding, there is authority for almost every part,¹ and there can be little doubt that the gilding is necessary to complete the harmony of the colouring. The small sketch in chiaro oscuro is merely intended to show the form that the pattern assumes in perspective, and has no reference to the actual state of the capital with respect to colour. From the absence of any outline incised in the usual manner, it is unlikely that any pattern was drawn on the corona, or on the lower fascia of this capital, although we can hardly doubt that they were painted in flat colour.

At the bottom of the plate is the band which ran along the peristyles immediately above the Panathenaic frieze. The authority for the design of the patterns upon the three divisions of this moulding is unquestionable, but the restoration of the painting is more doubtful than in the former example. The colours are supplied entirely from the analogy of other parts.

¹ In this moulding the restoration of the painting of the eggs is the most conjectural, no actual authority existing for the red colour introduced on the sides of the arrows between the eggs. The eggs themselves are blank, so that it may be fairly presumed, but not known with certainty, that they were left of the natural colour.

CHAPTER IX

ON THE COLOURING OF THE ATHENIAN PROPYLÆA

SEE PLATES XXIV XXV. XXVI.

THESE and the six following plates illustrative of the Propylæa¹ have been engraved from drawings prepared by my companion Mr. T. J. Willson, architect, who paid great attention to this building during our joint residence at Athens. The restorations of the colour given in these plates are not intended to be complete, but carried so far only as is warranted, or rendered highly probable by actual remains of colour.

In Plate XXIV. are given a plan and section of a portion of the ceiling of the central portico.² A very large mass of fragments belonging to this as well as the other ceilings of the Propylæa remain, and vestiges of the colouring have been preserved in many instances.³

The plinth of the central hall (see Plate XXX.) is composed of black marble, above which all is of white. We may presume that the walls above the plinth were painted, or at least intended for painting, in historial subjects; but of these, if they existed, no vestiges were to be found, nor yet of those described by Pausanias in the northern wing, which were already partially obliterated in his time.⁴

The first of the architectural members which exhibits painted ornament is the band, which runs round the interior at the same level as the abacus of the Ionic capitals. On this the patterns on the upper and lower mouldings are very apparent. We missed seeing the traces of the labyrinth fret on the vertical face, but its design was supplied by Mr. Cockerell. No colours could be discovered on any parts of this band, and the restorations have been taken from the analogy of other parts of the building.

No traces of colour appeared on the fascias of the architrave, nor on the soffit or sides of the main beams which supported the ceiling. The ovolo mouldings of both architrave and beams were enriched with the egg and dart ornament very clearly defined. The form of the eggs, when developed, is found to be accurately elliptical. The red colour shown on the lower fillet, and the blue on the surface of the ovolo moulding, are restored from the analogy of the similar moulding within the coffers. The soffits of the coffers were ornamented with stars and flowers. In some of these the blue ground was very positive, as also a narrow line of bright green on the margin of the soffits. (Compare Plate XXV.) The ovolo mouldings had distinct traces of the egg and dart ornament on a blue ground. The small fillets underneath them appeared to have been red. The upright face in every instance seemed to be blank. Traces

¹ For the sake of continuing the subject of the Polychromy unbroken, and combining the plates which are devoted to it, it has been thought better to enter upon this description of the painted ornaments of the Propylæa before that of the general architecture which follows in the next chapter.

² Compare the longitudinal section, Plate XXX. In Plate XXIV. the sectional line is taken between the Ionic column and the side wall, and the spectator is supposed to be looking to the latter.

³ This remark was more true in 1846 than it is at the present time. The coffers have been exposed to the weather, and the colour seems to have perished.

⁴ The face of the internal walls of this wing, as well as those of the central portico, have not been reduced to the intended surface, which appears only in a narrow margin of highly finished work, which runs down

all the angles, and parallel to the antæ and other architectural lines and mouldings (this margin is shown by Stuart in Plates XLIV. and XLV., second edition). The general surface of the walls has the appearance of a raised panel projecting very slightly from these smoothed margins. It may therefore admit of some question whether the pictures in the Pinacotheca described by Pausanias (I. 22) ὅστι δὲ ἐν ἀριστέρῃ τῶν προπυλαίων οἰκίῳ εἶχον γράφας, were painted on the walls. The surface, however, though not actually polished, is smoothed down to a sufficiently uniform face, and it is hardly to be supposed that paintings by the masters he mentions, would, if unattached, have escaped spoliation by Roman or other depredators, especially when we consider that more than five centuries had then elapsed since their execution. We may fairly conclude, therefore, that Pausanias is describing mural paintings, which we know to have been common among the Greeks.

of blue were found on the underside of the divisions between the coffers. The beads on these divisions are uncut, but had a pearl ornament painted on them.¹ On each side of the beads fine lines were cut for the purpose of defining coloured margins, one of which is the blue just mentioned, the other green. The profiles of the ovolo of the architrave, and the mouldings of the painted band, are given at the bottom of the plate, half the real size.

Plate XXV. gives examples of the coffers of the ceiling taken from the different parts of the Propylæa, also drawn to half the real size.

The coffers represented in Figs. 1, 2, 3, and 4 seem to have belonged to the eastern portico. Two or three slight varieties of pattern are recorded in the two latter examples. Figs. 5 and 6 are from the western portico.

Plate XXVI. is the capital of the antæ of the small order of the Propylæa.

The colouring in this example is taken from the antæ supporting the lintel of the window in the interior of the northern wing, where the colours have been better preserved than in those of the exterior. The form of the moulding is identical in both. Here the colours have been so well preserved that the restoration, as far as it goes, is based on very sufficient data.²

There are no traces by incised lines or otherwise of any enrichment on the corona of this capital, but there is every probability that this, as well as the flat member below the mouldings of the capital, were not entirely devoid of colour.

The reader's attention may be called to the remarkable forward inclination of the corona, about $\frac{1}{3}$ of its height (exceeding, therefore, even the Vitruvian rule—see Chap. IV. p. 38), and to the peculiar form of the square projections at the neck, well adapted to enhance the light upon a fillet separating bands of colour, but hard and meagre if executed, as has frequently been done in modern times, in plain stone.

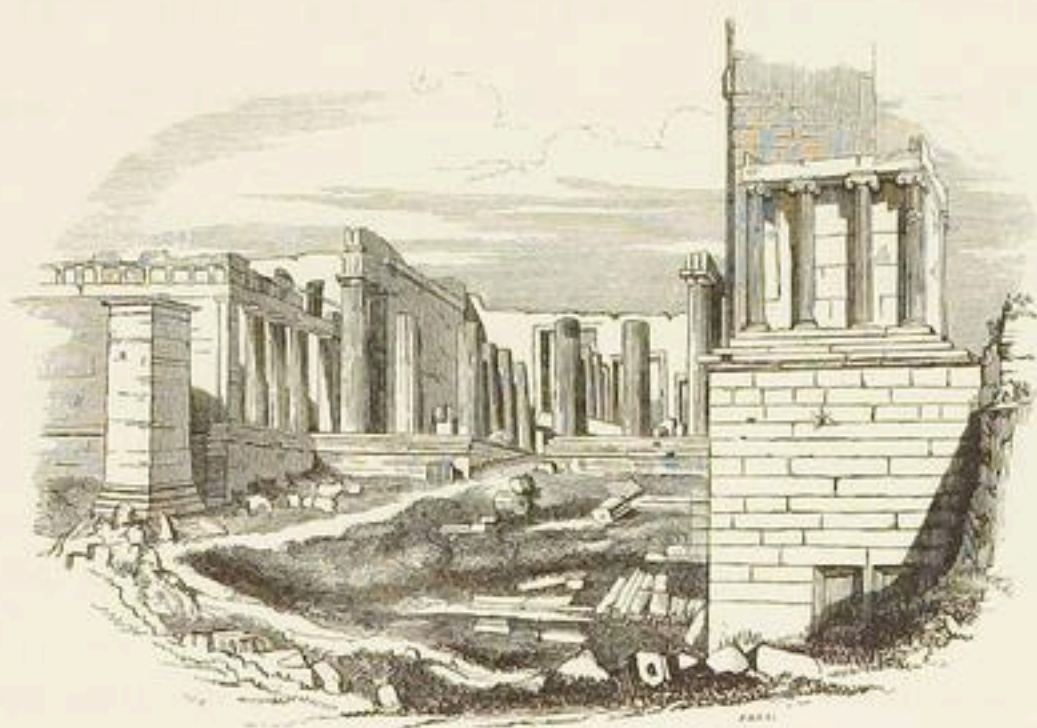
The above remarks are confined almost entirely to the colouring of the interior of the building. The colours and painted enrichments which have been observed on the exterior architecture, together with the details represented in Plate XXXI., will be described at the end of the ensuing chapter. Vestiges of colour were found on the Lycian Marbles now in the British Museum, strictly analogous to the Athenian examples.

For further information on this subject, see Kugler's work on the Polychromy of Greek Architecture and Sculpture. A translation of those parts of Dr. Kugler's work which have reference to architecture was communicated by W. R. Hamilton, Esq., to the Institute of British Architects, and was published in their *Transactions* in 1839.

¹ In a similar part of the coffers of the ceiling of the Parthenon (see Plate XV.), and in that of the Erechtheum, the pearl ornament is sculptured in full relief. In the Theseum it is what is called a flush bead, very slightly sunk; the effect having doubtless been aided by colour.

² It has been suggested by a high authority in such matters, that the employment of green, which has been observed on this and several other places, was unusual among the ancients, and that the colour now seen has been changed by the atmosphere from original blue; a change to which some qualities of blue are liable. To this it is mainly to be objected, that

where this conversion seems to have partially taken place, as in the capital of the ante of the Posticum of the Parthenon, the general mass of blue is merely spotted and streaked with a questionable green, whereas, in the example before us, and most of the others where green colour has been mentioned, the colour is almost as positive as though it had been freshly painted, and without the slightest indication of blue. It appears also that in Egyptian architecture, which cannot but have had great influence on the Greek Doric, green is often found on the coloured ornaments in a state of preservation which does not admit of doubt. The archaic sculptures mentioned in page 5 exhibit green colour.



CHAPTER X

SECTION I

GENERAL DESCRIPTION OF THE ATHENIAN PROPYLÆA. PLATES XXVII. XXVIII. XXIX. XXX.

UNTIL about the year 1835 the remains of the Propylæa were so much encumbered with the incongruous masses of a Turkish fortification, that Stuart, and also Mr. Kinnard in his valuable supplement to Stuart's labours, were unable fully to do justice to its magnificent architecture. Since then many points of interest have been brought to light. Those which principally affect the ichnography are the disposition of the Ionic columns on each side of the approach, the Temple of Nike Apteros,¹ and the foundation of an earlier building on the site of the Propylæa. The vignette at the head of the chapter represents the Propylæa as it appeared in 1847.

In front of the north wing, and continued under the line of the great staircase, is a wall of Piræic stone apparently of an older character than the present Propylæa, which probably formed part of some building on the same site before the Persian invasion.

Under the south wing of the Propylæa, as shown towards the right hand of Plate XXVII., are some foundations of highly finished Pentelic marble, upon which the present structure is built, altogether unconformably. If we consider the perfection of the masonry and material to be inconsistent with a date previous to the Persian attack,² we must suppose that these are the foundations of a structure of the nature of a Propylon, begun later than that period, but razed to the ground when Pericles determined on erecting the magnificent building which was designed by or entrusted to the care of Mnesicles.

The northern wing remains tolerably perfect; the southern is almost entirely ruined; two columns however of that wing remain which were embedded in the walls of the mediæval tower.

There are several circumstances which tend to the belief that the south wing, although no doubt originally intended (externally at least) to be symmetrical with the north wing,³ was never actually finished, but was left imperfect, somewhat in the manner shown in Plate XXVIII.

Some other parts of the architecture are left more or less unfinished. The external walls have not been reduced to the intended surface, but are left with the small squares of unsmoothed work, which were made use of in fixing the blocks, projecting a moderate distance in front of almost all the stones. The internal walls also, though smoothed, have none of them been reduced to the intended face, as has been already described in Chap. IX. page 58, note 4. The lower beds of the columns and the surface of the steps are exactly similar to those shown in woodcut Fig. 2 in Chap. III. sect. II. The faces of the columns

¹ This temple has been published with considerable detail, by Herr'n Hansen, Schaubert, and Ross. *Akropolis von Athen*, fol. Berlin, 1839.

² They are, however, evidently earlier than the Temple of Victory, which is generally referred to the time of Cimon.

³ The character of the masonry of the external walls and of the south-

east angle in particular, leads to this conclusion, viz. that only half of this wing was built; but as just sufficient room is left between the building and the edge of the Acropolis rock to have completed this wing symmetrically with the northern, we cannot entertain the smallest doubt that even if the wing actually was left unfinished, the anomaly was foreign to the original design of the Propylæa.

and antæ are smooth. The dimensions given in these plates have reference in every case to the finished surfaces.

Plate XXVIII. represents the Propylæa as it seems to have been left by the builders. There is very little positive evidence for the manner of finishing the wall behind the two wings. Sufficient fragments were found of the entablature and tympanum to restore the central pediment. There is no direct evidence to prove whether or no it had any sculpture; the inference rather inclines to negative such supposition. It may also possibly admit of question whether the acroteria were crowned with ornaments.¹

The pitch of the pediment is almost identical with that of the Parthenon. The rise is 1 in 4.142. As has already been noticed in Chap. III. page 27, the stylobate of the Propylæa, both centre and wings, is level, but the horizontal lines of the entablature were curved in the central porticoes of its two fronts. The increment of curvature which is here .119 in 68.1 feet, is produced by the addition given to the height of the central columns.

The wings are shown in the plate as covered with hip roofs. This restoration, which differs from that hitherto generally given,² demands some apology. The reasons for it are chiefly derived from two sources, which were not accessible when the well known restoration covering the wings with roofs forming two pediments fronting each other was proposed.

In consequence of the removal of the Turkish fortifications, we are now enabled to examine the eastern or back wall of the northern wing, which rises considerably above the small order, and seems to have attained the height of the architrave of the western portico. On the western face of this wall is an indented trace,³ about .25 deep and averaging .59 in breadth, of a roof, which both from its position, and from the provision left for the proper insertion of tiles of a corresponding dimension with those used generally in the Propylæa, together with the careful manner in which it has been cut, in every respect identifies itself with the original construction of the building. The angle at which this trace rises is 2.91 in 14.25, or 1 in 5 very nearly. Thus it appears that the roof did not run north and south, and if there was any pediment, it must have been to the west. But we were so fortunate as also to discover a wall tile, marked A in the section in Plate XXXIV. (where it is also given to a scale of $\frac{1}{16}$ of the actual size), which sloped equally in two directions, and bore at its lowest angle the fragment of an antefixa, which had its half faces parallel to the two sides of the wall tile. The angle which the inclined sides of this tile made with the bed amounted to a rise of .446 in 2.6, about 1 in 5.8, which, as the tile requires to be somewhat flatter than the general pitch of the roof, agrees perfectly with that derived from the trace on the wall. Other wall and ordinary tiles and antifixæ of corresponding dimensions were moreover found, which enabled the whole roof to be restored in an exceedingly probable manner.

The Plates XXIX. and XXX., with the help of the details elsewhere given, will explain the construction of the Propylæa, and of its magnificent ceiling, which seems to have attracted in an especial degree the admiration even of so dry and matter of fact an observer as Pausanias.⁴ The marble beams which spanned the interval between the architraves of the Ionic columns and the side walls have a longer bearing than is found in the ceiling of any other building at Athens.⁵ The lintel forming the doorway is composed of two stones about 22 feet long. Among the Athenian structures the size of these stones is exceeded only by the lintel over the doorway of the Parthenon and some of the architraves of the Temple of Jupiter Olympius.

The linings of the jambs and the margins of the openings of the entrances to the Acropolis, from whence the name Προπύλαια, were probably formed of bronze. The plug holes which served for the attachment of the metal are still visible on the lintel. The soffit of the marble lintel in the five principal gateways, as well as the doorway of the northern wing, is worked fair, and was probably visible; the

¹ A kind of flat base was found, worked out of the same block as the cymatium, and forming the acroterium in the centre of the pediment; but as this fragment exhibits no marks or sinkings, such as are found on the angle acroteria of the Parthenon, we have no authority for supposing that the centre or angles of the pediment carried any ornament. But perhaps we ought not to strain this absence of evidence too far against the general analogy deduced from other monuments.

² They are shown, however, covered in this manner in one of the

illustrations of the *Voyage du Anacharsis*, by the Abbé Barthelemy, Paris, 1795.

³ A portion of this trace may be seen above the entablature of the columns of the smaller order, in the vignette at the head of this chapter.

⁴ See Leake, page 143, and Pausan. I. 22.

⁵ The ceiling of the north portico of the Erechtheum nearly equalled this in bearing, but the whole space covered is much less than that of the Propylæa.

lining of the jambs seems to have terminated in a metal band or cornice underneath the lintel. The jambs are sunk, and quite rough, with grooves (see Plates XXVII. and XXIX.), for the reception of the wooden frame which carried the metal work.¹ Some fragments of a marble doorcase moulding, composed of two fascias, are at present attached to these jambs; but both from the clumsiness of their workmanship and their want of conformity with the rough sinkings above mentioned, they must be assigned to a later date than the time of Pericles. Perhaps they were a restoration in the decline of art, after some act of spoliation, as the golden shields taken from the temple of Solomon were replaced by his successor by shields of bronze. 1 Kings xv. 27.

The colours found on the fragments of the ceiling have already been described. All that can positively be asserted of the colouring of the walls is the bicolour nature of the materials employed. The *orthostatae*, or stones forming the base of the lateral walls, are composed of a black marble with a bluish tinge, from Eleusis, the Ἐλευσινιακὸς λίθος of the Erechtheum inscription. This deeper colour in the plinth is conformable with the usage of the ancients at Pompeii and elsewhere.² We can scarcely doubt that the walls above them were intended to be painted, although from the apparently unfinished state of the surface, mentioned in the note before referred to, together with the silence of Pausanias, who only describes the paintings in the northern wing, it cannot be known with certainty that this portico was ever actually decorated with mural paintings. The line of these *orthostatae* is returned by the broad step which forms the threshold under the five doorways, which is also of Eleusinian stone. These parts are distinguished in the two sections by a delicate tint.³ The return, under the colonnades of the wings, of the lowest of the four tall steps, which crown the great staircase, is of the same material (see the ground plan, Plate XXVII.), thus serving to separate the steps of the ascending flight from those forming the stylobate to the side porticoes.

The line of the inclined way within the building is easily identified. In some places it was formed out of the natural rock, in others of slabs of Pentelic marble; in both cases roughened by cross grooves. The vertical faces formed by its intersection with the stylobate are coeval with the structure. There are traces of wheel-ruts upon these slabs, but not sufficiently regular to enable anything to be deduced respecting the width of the carriages employed. The columns of the western portico are taller by nearly a foot than those of the eastern. The height of the latter is almost exactly $5\frac{1}{2}$ diameters. Hence we may expect to find in the eastern portico the normal proportions of the Propylæa. In the western the great height of the staircase seems to have required the additional height given to the column; or the relation of the building to the Acropolis generally, as seen from the Pnyx, or other such points of view, may have demanded it. From the two sections may be seen the way in which the two principal porticoes run into one another. The manner of their junction externally is more remarkable for its absence of artifice than for its beauty. We need not however carp at an indication of negligence in a subordinate part. It is clear that the sides of the Propylæa, where the awkward junction above alluded to alone is visible, were almost completely hidden by the buildings which butted against them; and the work on which Mnesicles was engaged was in all probability of a novel nature; and the management of the main design, in which his triumphant success must disarm minor criticisms, was sufficient to occupy his whole attention during the surprisingly short period (considering their perfection) that these works were in hand.

The inclination inwards of the columns, both in the large and small order, is nearly the same as in the Parthenon. As determined by a comparison of the plumbs with the measurements of the *scamilli impares*, it is found to be .22 in the whole height, which is about 1 in 130. The *antæ* lean forwards about .18 in 27.4, 1 in 150 nearly, and the walls inwards at an angle of about 1 in 70. The architrave and frieze are also inclined in the same way as the columns, but at a less angle, 1 in 140. The inclination forwards of the coronas of the main cornices, and of the *antæ*, of the sides of the ceiling beams, and of the vertical faces between the ovolo mouldings of the coffers, and some other details, are similar in their nature to those of the Parthenon, but the deviation from the perpendicular is generally more considerable.

¹ There are also grooves in the threshold, showing the extent of the finished doorcases (shown in Pl. XXVII.) white marble.

² The sub-plinth, however, upon which these dark *orthostatae* rest, is of ³ In the engravings, Plates XXVII. and XXX., the transverse wall has been drawn too thin; the figured dimensions are correct.

Great alterations have been made in the appearance of the Propylæa since 1846. In 1852 M. Beulé discovered a western entrance which he has described very fully in his work on the Acropolis.¹ Since that time also the mediæval tower has been taken down, not without injury to the general effect of the Acropolis, but it has yielded some interesting fragments, of which further description will be given, and very recently the brick vaulting of a large cistern which occupied the space immediately eastwards of the Pinacothek has been cleared away, and within the Propylæa itself the central line of approach has been laid more open, and search has also been made for foundations in continuation of the south wing where the design was left unfinished. The results of these investigations have been entered on the plan (Plate XXVII.)

The original approach to the Acropolis, before the Propylæa was built, was evidently nearly where the present entrance is, namely at the base of the tower surmounted by the Temple of Victory. Close to the foot of this tower are cross grooves cut in the rock (shown on Plate XXVII.) which must have been intended to serve the purpose which they still perform of giving foothold over a steep part of the ascent. The path then crossed over towards the spot now occupied by the Agrippa pedestal, and thence ascended by a zigzag where some more grooves may be seen on the rock (see Plate XXVII.), but these grooves were all hidden when the work of Mnesicles was completed. Still the main entrance to the Acropolis would remain unaltered.

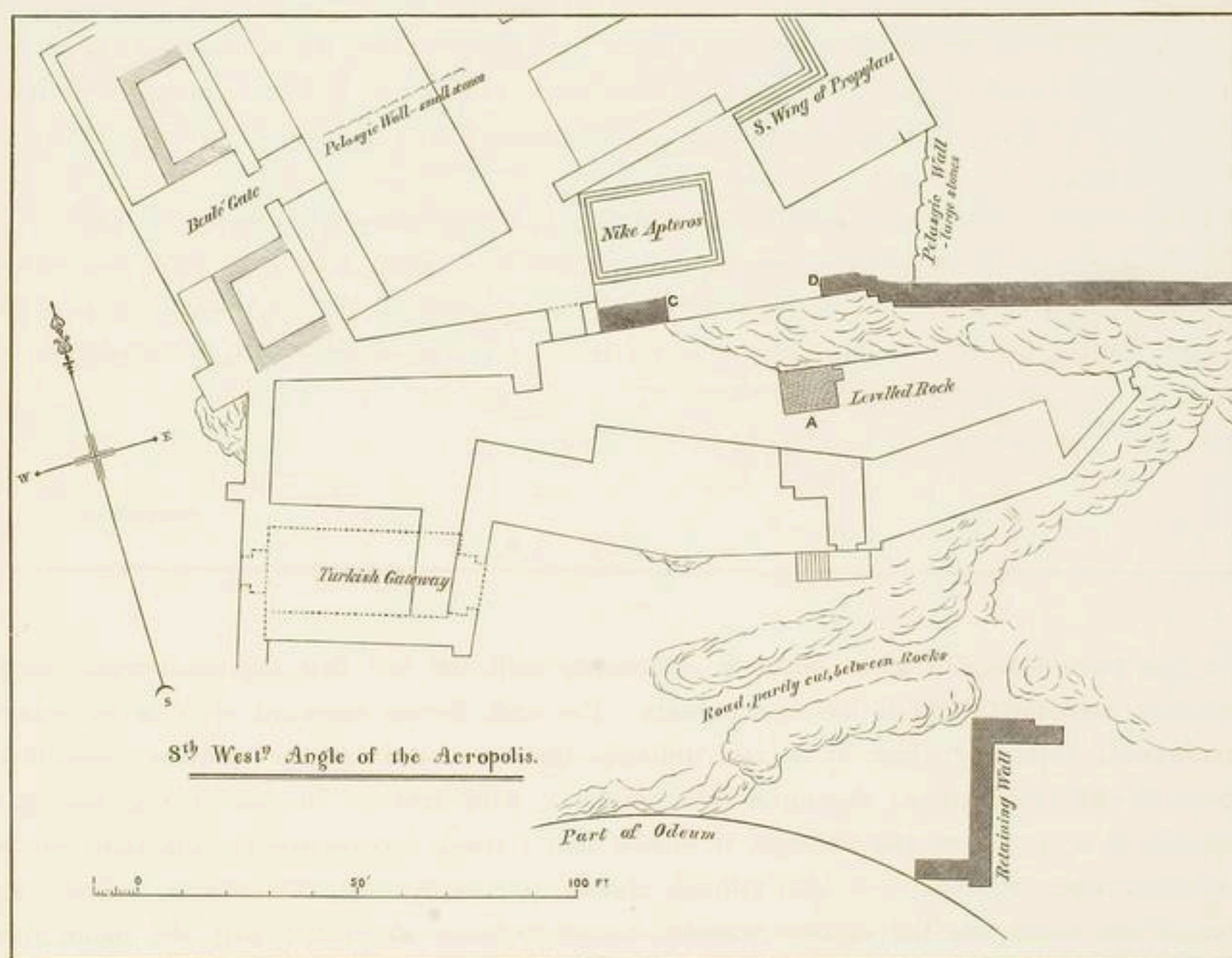


FIG. 4.

As it is of importance to the due understanding of the Propylæa to have a clear notion of the approaches to the citadel, I have given on a woodcut a plan taken from a careful survey of the adjacent rocks and buildings on the south side, followed by another, Fig. 5, showing on the same lines the roads and fortifications as they probably existed in the time of Pericles.

In his time it is probable that neither the lower flight of the staircase nor any gateway looking westwards could have existed, for at that period the Acropolis must have still been regarded as a citadel, and it is unlikely that a gateway would have been formed at a spot which would so much weaken it. However, the western gateway and the flanking towers were built previous to the time when Sylla besieged Athens, and who as M. Beulé has very probably suggested (*Acropole d'Athènes*, vol. i. p. 107), dismantled the works and destroyed the gateway, which was afterwards

¹ *L'Acropole d'Athènes*, par E. Beulé; Paris, 1853.

rebuilt with modifications in the time of Valerian, *i.e.* about A.D. 256. The gateway which we now see, although in actual construction decidedly of debased work, is put together with some feeling for classical tradition, and some materials taken from ruined buildings of the very best period were used in its construction, especially the Doric entablature which surmounts the wall over the gateway.

The cross grooves above mentioned, which are near the point B of the woodcut, show the direction of the road at B, at which point there was very probably a gate; but if unsupported by outworks such as are shown on the woodcut, this would have offered an inadequate system of defence. A very important point in the proposed scheme is the rock-cut foundation at A, which seems to have been

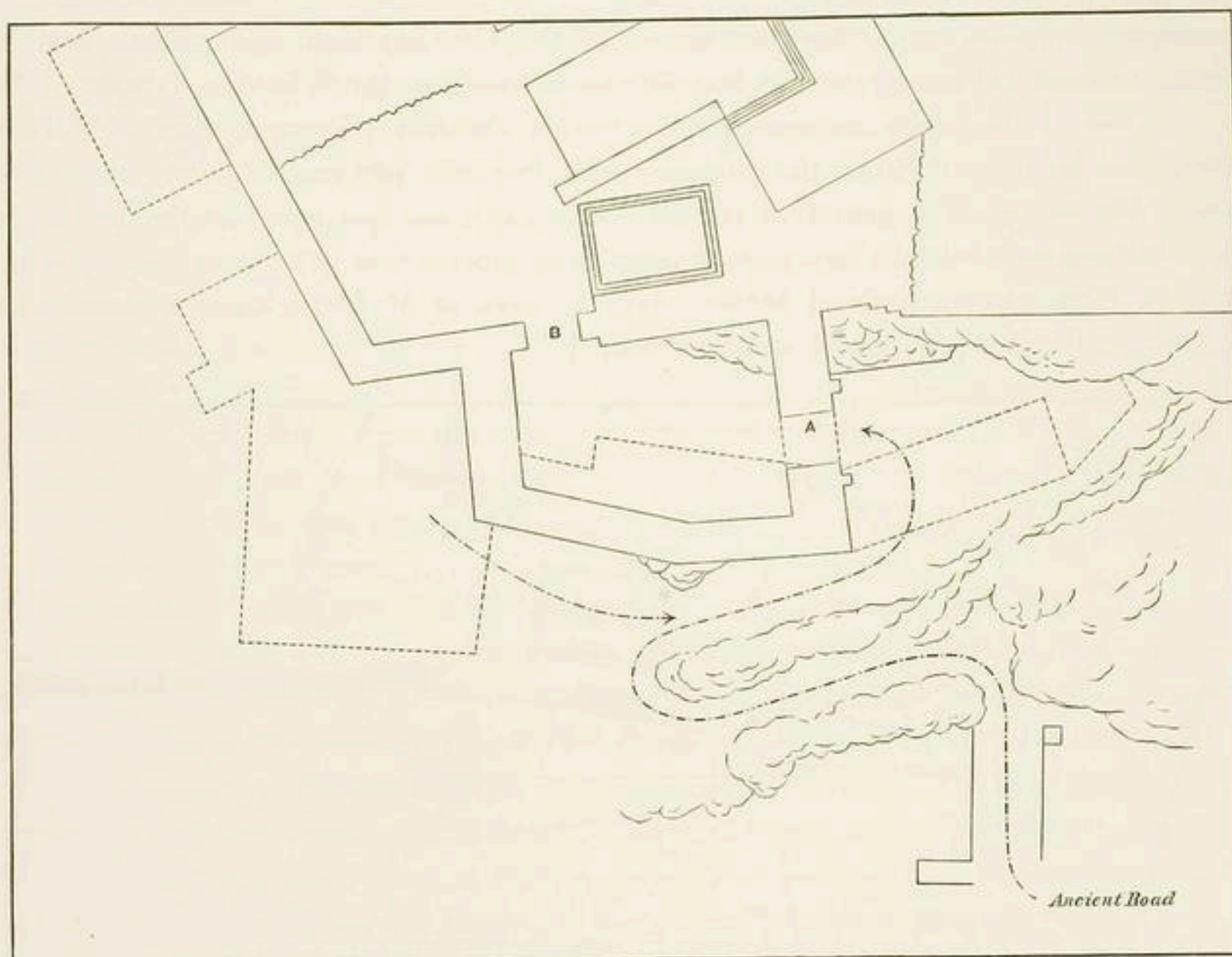


FIG. 5.

that of a gate pier, especially when taken in connection with the fact that the contiguous portion of the Cimonium between C and D has been rebuilt. The walls shown westward of A in the second plan are hypothetical, excepting that it is not unlikely that the wall of the present guardhouse is built upon the old foundations. Again, if we suppose a gate also at B (one of the nine gates of the Acropolis as designed by the Pelasgi), it would have formed a defensive combination very similar to the chief entrance at Tiryns. It also follows, almost necessarily from the evidence of the retaining wall towards the south and the narrow roadway formed between the rocks, that the main approach, of which there are also other traces farther eastwards,¹ was by the zigzag course indicated by the dotted line, by which any soldiers, as they approached the gate, would have exposed their unshielded side to the main wall of the citadel not less than 60 feet above them. There is a levelled area of sufficient extent in front of the supposed gate. There may also have been a branch road, converging from the west along the line occupied by the present Turkish gateway.

In its final and most complete state, but subsequent to the time of Pericles, the great staircase, as shown in plan on the Plate and in section in the woodcuts in page 65, was divided into two main flights, which were separated by a landing or platform of about 20 feet wide, at the level of the base of the tower on which the Temple of Victory is built.

There was another approach, but by foot only, on the north side of the Acropolis, which passed

¹ At several places on the south side of the Acropolis are traces of a carriage road, which, emerging from the street of the Tripods, passed between the Theatre of Bacchus and the Choric monument of Thrasylus, and in front of the Temple of Esculapius, and arrived at the point under consideration.

by the cave of Pan and up the narrow and winding staircase shown on Plates II. and XXVII., and this also converged to the broad platform already referred to.

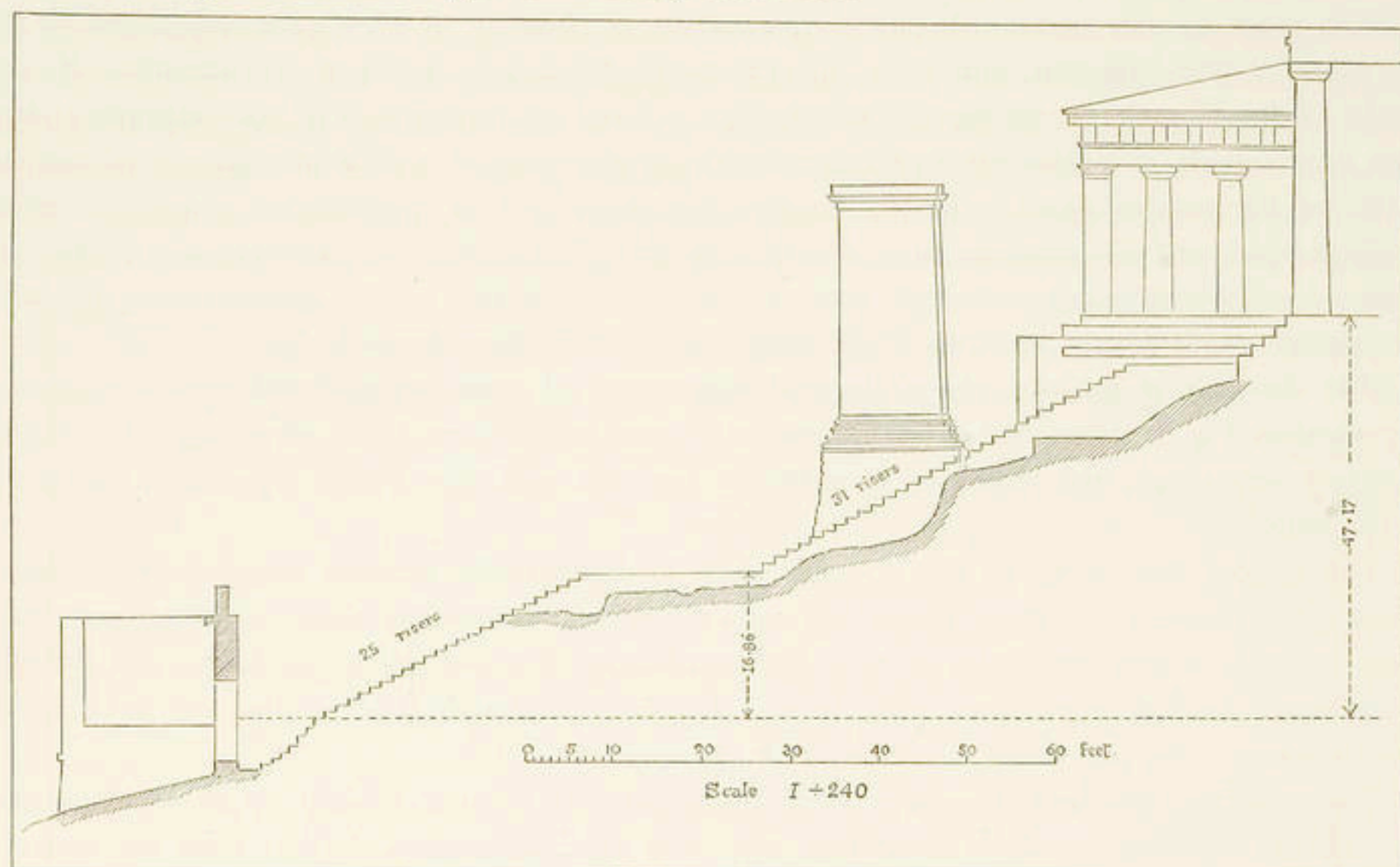


FIG. 6.

The lower flight of steps, which leads downwards from the broad platform described above to the Beulé gateway, is clearly defined in extent and direction, with the exception of a few of its upper steps, by the bed cut in the rock. It has a gradient of $27^{\circ} 26' 27''$, and occupies a width equal to the whole extent of the front of the Propylæa, with no interruption from a central plane roadway

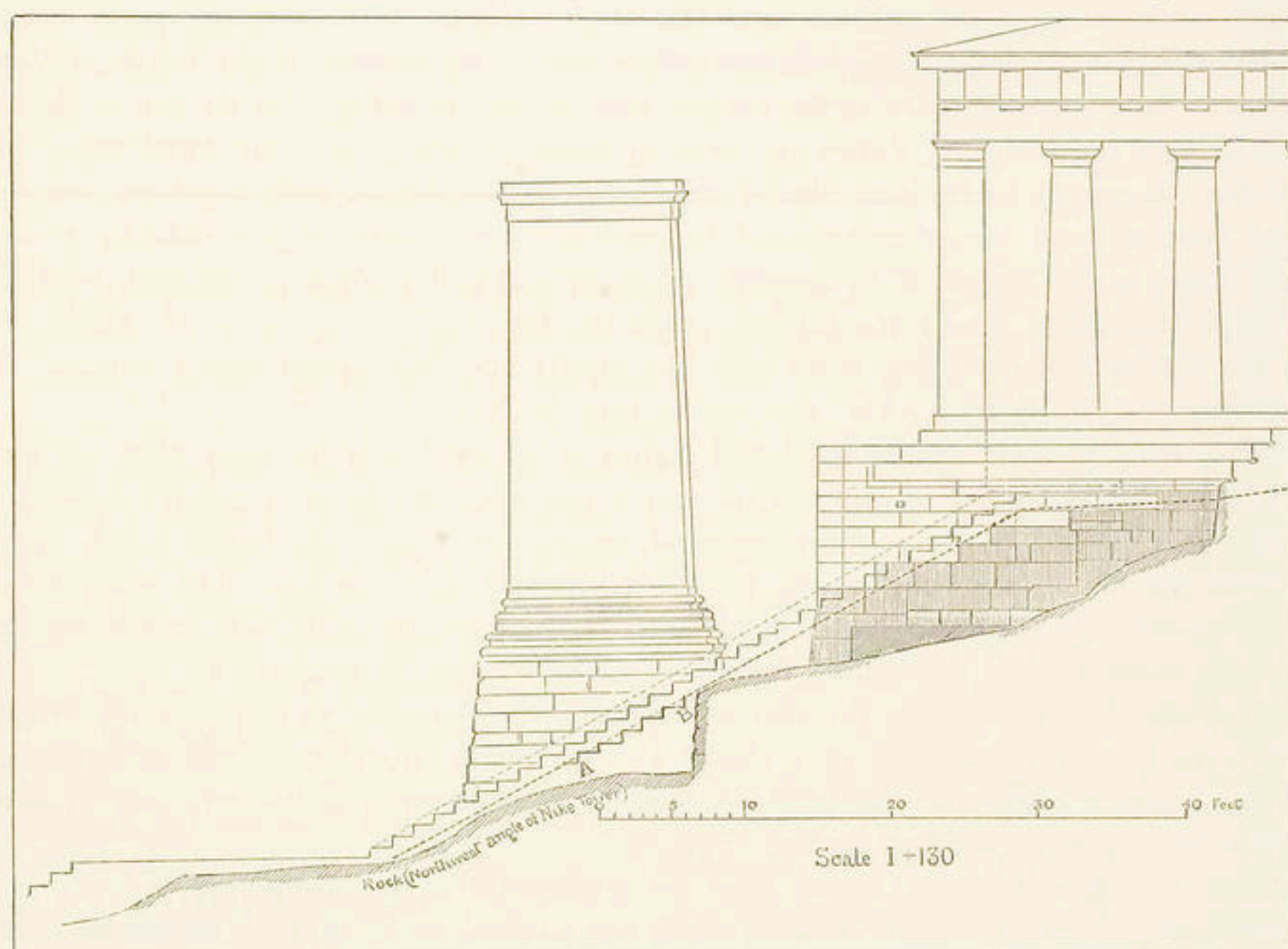


FIG. 7.

like that which breaks the continuity of the upper flight. Although the gradient of these steps is about the same as that of the upper flight, the steps themselves are lower, being $.656 \times 1.359$ instead of $.79 \times 1.60$, a difference which confirms the view taken above that they belong to a later period.

S

The section of these steps is also triangular, a device well known in modern work, but suggestive of an economy unknown to the Periclean period.

The exact position and finish of the upper flight of steps is of very great importance to the true effect of the Propylæa, and there are fortunately indications sufficient to determine it very closely. I found marks in the base of the Agrippa pedestal of the insertion of six consecutive steps. They were formed in a foundation of rather friable conglomerate of a different character of masonry to that of the pedestal itself, which is for the most part built of gray marble. From the points so discovered, carefully measured and levelled, is derived a gradient of $27^{\circ} 44'$ which must be a very close approximation, although some correction is allowable, as the measurements are taken from the somewhat rough insertions of the steps and not from their finished edges.

The character of the masonry of the wall supporting the north wing should now be examined. The woodcut Fig. 7 shows that a certain portion is marble and part Piræic stone, the latter for the most part very rough, and projecting considerably from the wall, was clearly intended to be covered by the steps.

The stepped line shown in the woodcut, which is drawn to the gradient assigned by calculation, almost entirely covers the Piræic stone, but with a very small alteration, about $1^{\circ} 30'$ steeper, which would be quite within the limits of allowable modification, it would do so absolutely, and the edge of the upper landing would then coincide on plan with a straight line joining the antæ of the opposite wings. See the dotted lines drawn on the woodcut.

This staircase has been shown in some restorations as running straight up to the four great steps of the stylobate. And, in accordance with this view, some steps derived from the materials of the lower flight have been recently so arranged on the south side, but besides the objection that these steps fail to cover the rough Piræic stones, there is an awkward and sudden break of gradient between the smaller and the larger steps, whereas a broad landing connecting the wings as above explained obviates this completely, and also produces an excellent architectural effect and offers a most desirable point of repose on the ascent.

The substructions of the southern wing offer similar evidence to those on the north side, but are more complicated, owing to the small intermediate stair giving approach to the Temple of Victory, and they are also partly concealed by the modern steps already referred to. On the face of the tower which supports the Temple of Victory are some additional projections in rough Piræic stone¹ which would not be covered by the same line of steps which suffices for the walls under the wings. To conceal these a much steeper angle would be required. The solution of this difficulty is offered by the access to the Temple of Victory—the ascent to which, if made from the west, would have required a staircase of exactly the required gradient. The rough stones, some of which project from the wall as much as 2 feet, would have been rightly placed to support such a staircase. This is shown on the plan, Plate XXVII., and also on Plate XXXIV.

For a width of about 12 feet the central portion of the staircase of the upper flight was formed into a plane surface instead of steps, except that it was roughened by cross grooves about .3 foot apart to give foothold, presumably for beasts of burden² or draft. The incline would, however, have been still too steep for horses, etc., to ascend yoked in the usual way. The ascent for cars, however, could have been effected by sending the animals forward until they reached the flatter part of the roadway where they could have been re-yoked by means of long traces.

When the road emerges on the general surface of the Acropolis, eastwards of the Propylæa, the rock itself is cross channelled in a similar way to that described below, and in certain parts marks of supposed wheel-ruts may here and there be noticed, but it is not very easy to identify them; the cross grooves, however, are very apparent.

Much new light has been thrown upon the arrangement of the south wing by some of the material recovered from the mediæval tower which was pulled down in 1874. A considerable number of the stones represented in woodcut 8, letter A, were found split longitudinally. There is no

¹ The face of the tower is entirely of Piræic stone, but generally of finished work.

² A small fragment of this is preserved, and has been placed conformable

with the modern restoration of the steps mentioned above. In 1883, however, I was able to look underneath it, and found that it rested on fragments of recent pottery. It is doubtless a genuine fragment, but not *in situ*.

difficulty in fitting them together, particularly a pair containing the antæcap, so as to give the original dimension of the unbroken stone which formed an isolated pier 5.76 broad by about 3.04. A portion of this pier agrees in its subdivisions, namely $3.38 \times 3.04 \times 1.67$, with the dimensions of the antæ of the north wing, which are $3.33 \times 3.03 \times 1.65$. There can be no doubt, therefore, that the pier to which these stones belonged must be placed at the north-west corner of the south wing, where also are some foundations which exactly suit these dimensions, viz. 5.76 north to south $\times$ 3.04 east to west. If we follow this line to the southward, we find at first no foundation of pier or wall, but a marble pavement anterior to Mnesicles's work and in connection with the Temple of Victory. Here therefore must have been a wide opening without any wall or column, but a little farther on, where the place of the pier or anta at the south-west angle of the unfinished wing should be, the evidence has been destroyed—because the whole of the original foundation, whatever it was,

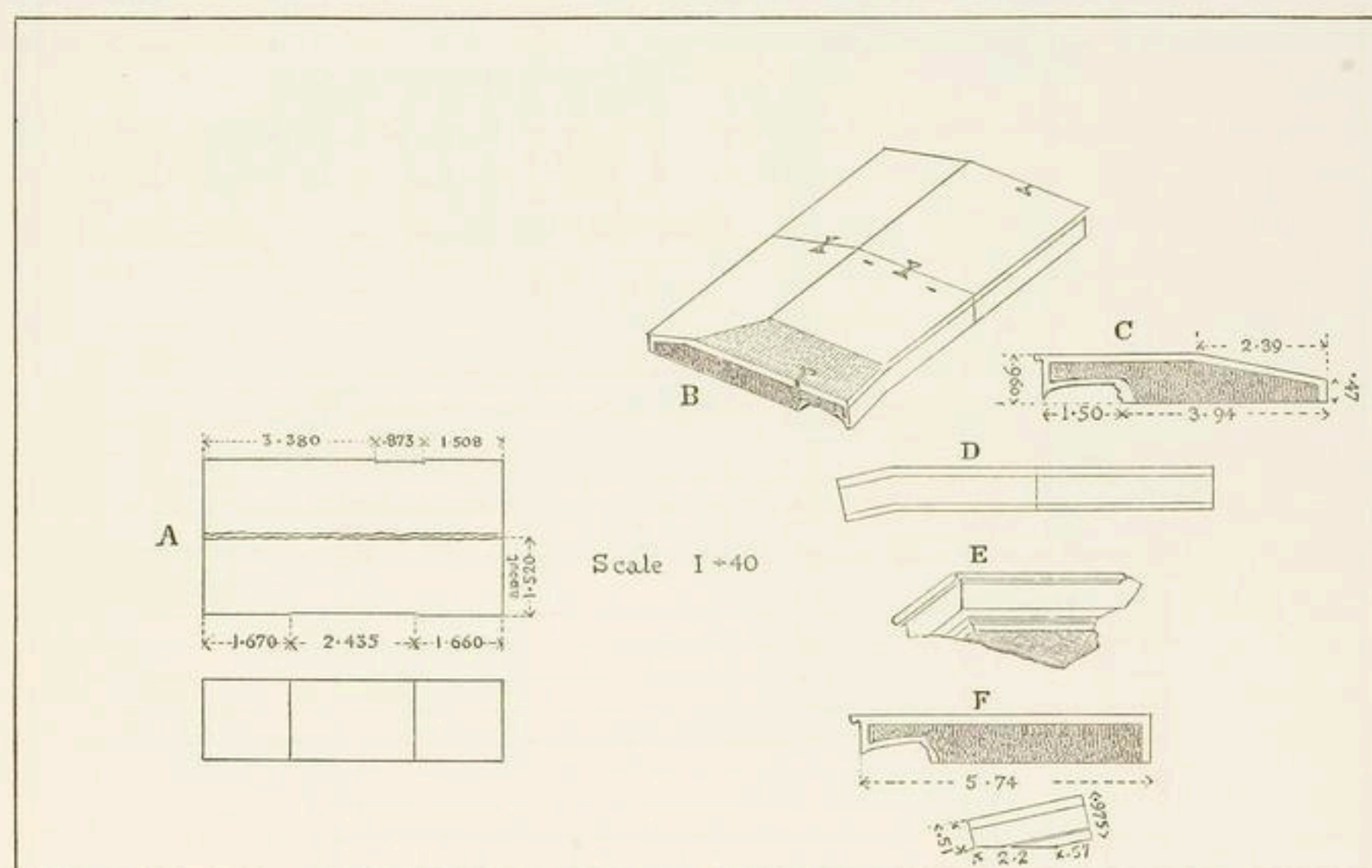


FIG. 8.

has been uprooted for the sake of forming a mediæval cistern; and here in the plan I have supplied a pier corresponding to that at the north-west angle,¹ and this would leave an opening of the extent of three metopes, which would be analogous to the central opening of the great portico. It will be understood that this arrangement of the western face of the south wing is not proposed as the architect's scheme for his finished design, but that to which he was driven when obliged to terminate his work prematurely.

A foundation wall, which seems to be of the same date as the Propylæa, runs from the existing anta southwards in the direction of the fortification wall, but some squared stones which form part of the latter, and are shown on the plan, Plate XXVII., though Hellenic, judging from their material (gray marble), and workmanship, are probably later than the time of Pericles. It is reasonable to suppose that the foundation wall referred to never received any superstructure, but that a side passage was here left with steps leading to the upper levels of the Acropolis.

The stones obtained from the tower not only confirm the arguments given above, viz. that the wings were covered with hipped roofs, but also explain the manner in which the curtailed design of the south wing was actually finished. These stones are represented in elevation section and isometrical perspective in woodcut, Fig. 8, and in their places at the springing and summit of the half pediment in Fig. 9.

¹ In Herr Bohn's valuable and elaborate work *Die Propylæen der Akropolis von Athen*, fol. Berlin, 1882, he supposes the north-west pier alone to have been built, and that the line of the building then fell back as far as the first column, thus leaving the colonnade of the wing a mere thin screen without any backing at the angle, but, in addition to the argu-

ment which may be drawn against this arrangement from its extreme unsightliness, enough is known as to the form of the hipped roof of the wings to make this proposed plan impossible. It is evident that the south-west angle must have been completed either by such a pier as I have suggested or in some other suitable and solid manner.

The measurements of the springing stone F (see woodcut Fig. 8) give for the pitch of the roof $12^{\circ} 9'$. That derived from the traces on the walls on the north side is $11^{\circ} 30'$. The angle contained between the lines of the pediment stone D is $168^{\circ} 5'$. This shows distinctly that it could not have formed the summit of a complete pediment, as Herr Bohn has supposed, for that would have required an angle of about 156° between the two sloping lines. This stone, therefore, must have served to combine the inclined line of a half pediment with a horizontal cornice as shown in the woodcut. The stone which adjoins D, as determined by the cramp marks common to both, has the same section. Both these stones are sloped at the back, the angle being $12^{\circ} 15'$ measured from the bed, but the slope on the former stone marked B is not carried continuously along its whole length, but is cut off at a *mitre* line, *i.e.* a straight line forming an angle of 45° with the running length. Now it is impossible

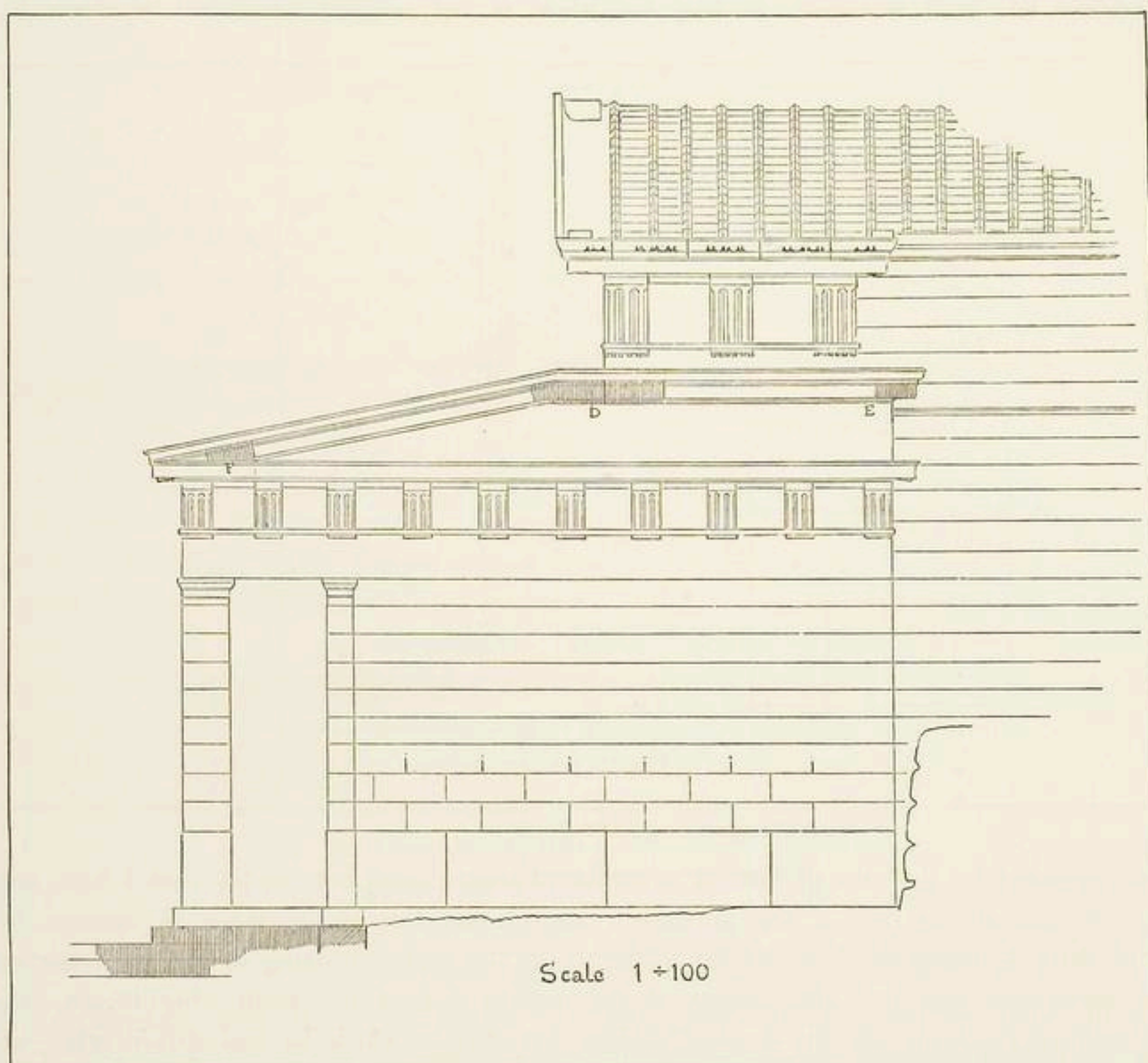


FIG. 9.

to avoid seeing that here was the departure of the hipped roof which sloped both towards the north and the west, and that such was the shape of the roofs of the wings we have this further evidence. In page 61 the trace upon the back wall of the Pinacothek has been described, and, now that the tower has been removed, the corresponding trace of the southern wing against its back wall is equally visible. Compare also the description in the same page of the angle tile.

In the woodcut, Fig. 4, part of the western portion of the roof of the main portico is also shown. The cymatium was pierced in a curious manner to allow of the discharge of the rain-water through holes formed between the interstices of the egg pattern, which elsewhere is merely grooved on the surface.

On the left hand also of Plate XXIX is given an enlarged section of the entablature of the longitudinal wall looking the reverse way, that is, towards the western main portico. The corona of the cornice of the wall is level with that of the western portico, but has less projection, 1.67 instead of 2.12, and there is neither frieze nor architrave, consequently it would appear that a cymatium of less height was thought desirable. It is here, therefore, that a place is found for the

truncated cymatium shown in Plate XXXIV. The fillet at the base of this fragment had the same section as that of the complete cymatium, showing that its position must be looked for somewhere upon this cornice.

The cornice of the smaller order has been recovered from the tower, and still exhibits patches of colour upon it analogous to that shown on the cornice of the Parthenon in Plate I. This member completes the entablature of the small order which is engraved on accompanying woodcut.

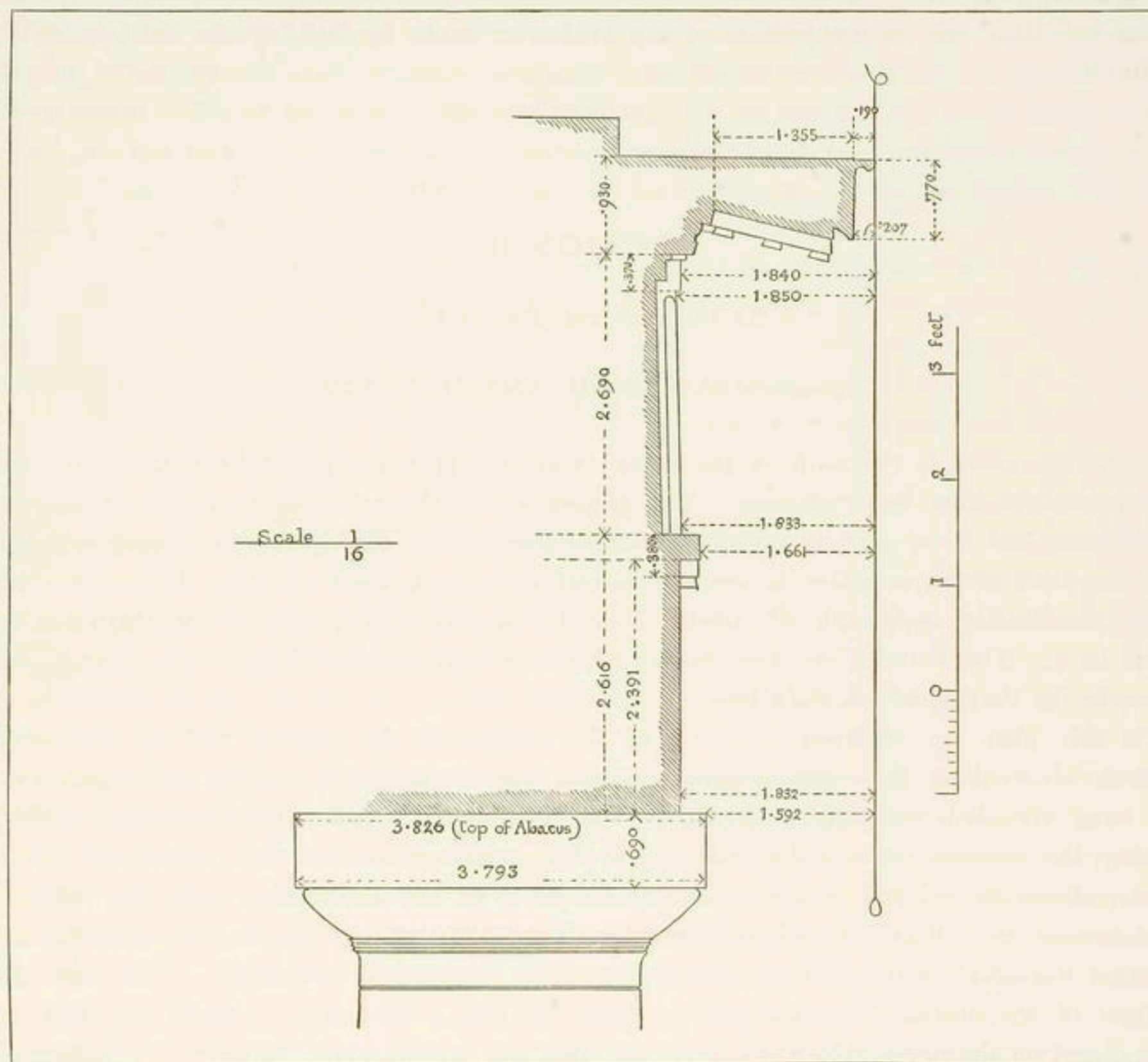


FIG. 10.

To the south of the unfinished wing, and also outside the central hall towards the eastern portico, are the substructions already mentioned in Pentelic marble, and in continuation of them may be seen a bed cut in the rock under the central doorway of the transverse wall (see Plate XXVII.) The western portion of these substructions is nearly square with the wall of the citadel, and is backed by the massive Pelasgic wall, behind which the ground rises considerably.

Towards the south-east of the Propylæa the rock has been cut away and the ground levelled for a distance of about 10 feet. Passing round the east portico to the north-east quarter we come to the space where the large cistern vault already mentioned has been cleared away. The bed of this cistern is excavated in the rock, and although the lining of its walls and the vault were of mediæval construction, it seems to have occupied the area of an ancient cistern, which was supplied with rain water from the surface of the Acropolis; for conducted into it we find a channel cut in the rock about 1.75 wide and 1.5 deep, which has every appearance of having been ancient work. This was first led into what seems to have been a filtering chamber, and there is also a place where the rock has been left in the shape of a sloping platform, as though the cistern had been used as a bath, and the sloping platform left to give access to it (see Plate XXIX.) The surface water with which it was supplied would have been more suited for bathing than for drinking, and other better sources for that purpose would have been available.

T

It is clear, however, from indications in the north wall of the Propylæa that a roof over this area was originally intended, and it would have formed a very noble apartment about 75 feet long $\times$ 42 wide. Some older foundations are seen running obliquely into the walls which bound this area towards its north-east angle. These foundations are approximately square with the north wall of the citadel, and belonged to the building described as the Chalcotheke in Chap. I. Sect. 2.

The preparations for a roof, to which I have referred, are repeated on the south side of the Propylæa, there can therefore be no reason to doubt the original intention of a similar apartment on this side also, but no preparations of any kind were made for building the walls or utilizing the site.

SECTION II

DETAILS OF THE PROPYLÆA

PLATES XXXI. XXXII. XXXIII. XXXIV.

PLATE XXXI. refers to the angle of the eastern portico. This example of Doric differs in several minor particulars from the Parthenon. The proportions of the columns are almost identical, but the architrave and frieze are rather greater, and the cornice, considerably less in proportion. Again, whilst the pitch of the pediment in the two examples does not differ sensibly, the mutules make a more considerable angle with the level. Here the rise is 1 in 4.256; in the Parthenon it is only 1 in 6. The mutules are here supported by an ogee bed moulding. The corresponding member in the Parthenon is a plain band.

On this plate are references to most of the vestiges of the painting and of the coloured ornaments observed on the exterior. The cymatium was adorned with the egg and tongue pattern of a large size, indicated very positively by the usual incised line. The hawksbeak moulding crowning the coronas both of the raking and horizontal cornice had the pattern of Egyptian character, alternately red and blue, as in other examples. On the vertical face, under the stillicidium of the cornice, faint traces of red were visible. The soffit between the mutules appeared to be red. One fragment retained distinct though incomplete traces of a honeysuckle. The sides, soffit, and front of the mutules bore also distinct traces of blue. The guttæ showed no remains of colour, except on the under side, where a circular ring was traced, which formerly was distinguished with colour or with gold. The ogee moulding under the mutules had leaves similar to those which enrich the lower moulding of the band or string under the Ionic architrave given in Plate XXIV.

A comparison of these and other examples seems to point out that it was the general practice among the Greeks to decorate mouldings of a curvilinear profile with patterns composed principally of curves; and flat bands and strings with rectilinear figures. Although the honeysuckle occasionally occurs on flat surfaces, no instance seems to have been found of a curved profile decorated with a labyrinth fret, or other right line pattern.

As has been before said, it appears that the faces of the corona of the principal cornices were in all cases plain.

The example of the Ionic order given in Plate XXXII., bears a considerable resemblance to that of the small temple on the Ilissus (see Stuart's first volume), now unfortunately destroyed, and, like it, is remarkable for its simplicity.¹ The abacus was ornamented with painted eggs. Those on the neck, between the volutes, were sculptured in full relief, but under the *pulvina* of the capital the outlines were merely indicated by a slight relief, and the effect was no doubt aided

¹ A full-sized outline of the volute of this capital, together with most of the mouldings and various other particulars of the Propylæa, are given in the volume of the *Wiener Bauzeitung*, published in 1840-41, contributed by Herr'n Hofer and Schaubert.

by colour. Respecting the nature of the spiral curve (*ἀνθέμιον*)¹ of the volutes (see Appendix, Art. 10).

The entasis of the Ionic columns seems to have been very slight, and, owing to the ruined state of the shafts, it could not be satisfactorily ascertained. The small plinth below the torus of the base is circular, and the whole base is contrived so as to have as small a projection and to occupy as little space as possible. It should be noticed that the joint of the base is on the top of this plinth, the whole surface of the stylobate having been worked off beneath it.

Another point worth noticing in the construction of the Propylæa is that in the architraves and other principal beams when formed of two stones (see the sections in Plate XXX.) a part of the material in the inside of the beams which did not contribute to the strength, but would have added weight only, has been cut away—thus anticipating the scientific theories respecting flanged girders of recent years. This was done also in some of the architraves of the Parthenon, but not so generally as in the Propylæa.

Plate XXXIII., so far as it relates to the entasis, has been already described in Chap. V. It is here only necessary to observe that the two Doric orders given in this plate, in their general dimensions bear to each other nearly the proportion of 10 to 7. This ratio obtains exactly in the breadths of their abaci. It is remarkable that in both these examples the breadth of the abacus is considerably greater at the top than at the bottom. This may have been intended to increase the contrast in the effect of light on the abacus, compared with that on the faces of the entablature which incline in a contrary direction. This peculiarity is not found in the other Athenian examples.

At the top of Plate XXXIV. is a general section through the Propylæa, looking southwards, and extending so far to the west as to show the Temple of Nike Apteros, and the trace of the great staircase upon the flank wall. This wall was surmounted by a parapet adorned with exquisite bas-reliefs, of which several fine fragments remain, for the most part representing the Goddess Victory. These, as well as the temple, have been well illustrated in the *Akropolis Von Athen*, etc., cited above, page 60.

In the middle of the plate are represented some of the more important among the fragments of the tiling of the Propylæa, which have served as data for the restorations in the previous plates.

The reader may compare the description of the Eleusinian Propylæa in the *Unedited Antiquities of Attica*, with that given above. The former seems to have been almost a servile copy of the Athenian structure; for, whilst the general forms are almost identical, the details are greatly inferior.

At the bottom of the plate is given a sketch of the plan of the temple of which the site has been discovered between the Parthenon and Erechtheum, already referred to in page 5.

¹ Ἀνθέμιον, ἡ γράμμη τῆς ἑλικωειδούς ᾗ ἐν τοῖς κίονσι. Hesychius. Compare also the Erechtheum inscription, and Wilkins's *Profusiones Architectonicae*.

CHAPTER XI

GROUND PLAN AND DETAILS OF THE ARCHITECTURE OF THE THESEUM

PLATES XXXV. XXXVI.

THE Temple of Theseus, although surpassed in grandeur and richness by the Parthenon, is scarcely less harmonious in its proportions, and is almost as refined and perfect in its construction. It will be seen by reference to the ground plan that the length and breadth of the temple on the upper step are respectively 104.230, and 45.011 feet. These dimensions, though not in themselves immediately commensurate, were evidently connected by some intentional relation, for they are found to harmonise with other Athenian measures, the front of the Theseum being $\frac{1}{3}$ of that of the Parthenon, which gives by calculation 45.04. In the Theseum, however, the flank and front are immediately commensurate on the lower step; for the dimensions here become 106.708; and 47.459; and $\frac{1}{3} \times 106.708^1 = 47.426$.

It has been suggested (2d ed. Stuart, vol. iii. p. 66, note b), that the fact of the stylobate of this temple having only two steps instead of three, is accounted for by its having been built as an heröum.² Very little weight, however, can be placed on this argument; temples dedicated to the greater divinities had not always three steps.

Measurements of the full diameters at the base of an angle column and one adjoining it, and the differences in the angle intercolumniations are given on the plan. In the section at the top of the plate, taken through the eastern portico, the columns are shown to be inclined inwards. The result deduced from the plumbs of the columns and from the measurements of the scamilli impares shows that this inclination was the same as that given to the columns of the Parthenon, viz. $\frac{1}{150}$ of the height. The entablature seems to have inclined backwards 1 in 120, and the walls and antæ to have been perpendicular.³ In the east portico the ceiling still remains almost perfect.

On the back wall of the pediment are found recesses adapted to the reception of the timbers of the roof. Apparently the whole weight of the roof rested upon these purlins, which, judging from the size of the openings, were in depth and breadth about 1.2.

¹ The dimension 106.7 may have had some particular affinity with the dimension 1.066 which has been observed in the Erechtheum. See Appendix, Art. 18.

² Professor Ross and some other authorities contend that the building in question is not the heröum of Theseus, but the Temple of Mars. I see no sufficient reason for dissenting from the accepted nomenclature, but it is no part of the object of this work to enter into such controversy. The name, which the building now bears, it will probably ever retain, at least in common acceptance.

³ In this temple, a vaulted roof, which has at some time been built on the walls of the cella, has pushed them a little out of the perpendicular; and as they were connected with the columns of the peristyle by the beams of the ceiling, the same pressure has also pushed outwards the columns and entablature of the flanks. On the south side, in the centre of the flank, the wall, which seems to have been perpendicular, now leans outward .1 in its whole height. The entablature, which inclined inward 1 in 120, is now very nearly perpendicular, and the columns, whose inclination originally

amounted to about .13, now incline only .06 in their whole height. On the north side this disturbance has been greater. The central column leans inwards only .024. The columns have yielded to the pressure partly in horizontal shifts, and partly (this especially on the north side, where the stylobate is raised considerably above the rock) by a slight yielding in the foundation. In consequence of these derangements the plumbs could not be relied on, except in the columns of the fronts, which are unaffected by the pressure of the vault. An average obtained from several of these columns, and corrected from horizontal shifts, etc., gives .136 as the amount of inclination in the whole height. The difference of the scamilli impares as obtained from an average of all the columns of the two fronts is .0355, of which .013 is due to horizontal curvature, .0225 therefore measures the effect produced by inclination on a length of 3.13, namely that of the diameter of the column within the flutes. From this we obtain .123 for the inclination in the shafts, or .117 in the whole column, deducting .006 for the counter inclination of the capital. The mean between this quantity and .136 as obtained from the plumbs, is .126, which is $\frac{1}{150}$ th of the height of the column very nearly.

The inclined lines of the pediment of this temple are found to have a delicate vertical curvature, to which we may assign an increment of about .025 in 25 feet,¹ which is nearly the same ratio to the length of the arc as in the other instances of curvature in this temple. This curvature seems to be a refinement peculiar to the Theseum.

As it has been questioned whether the western pediment was adorned with statues, I have given a plan of the upper bed of the cornice of that front, on which there are evident traces of the positions which the sculptures occupied.

On the right hand of the plate is shown a fragment of the cymatium. This moulding in the later Doric seems seldom to have been continued along the eaves, but to have been placed on the pediment only; the fragment here represented, of which the face is very upright with respect to its lower bed, does not seem well calculated for the pediment; but, if used as an eaves gutter, it would occupy very fitly the narrow raking surface or bed which is left on the top of the horizontal cornice on the flanks of this temple.

The sections of the columns D and C give the measurements of the entasis, taken within the flutes, of two different columns of the peristyle. This has already been described in Chap. V. page 43.

Referring to Plate XXXVI., we see that the pavement of the Theseum, like that of the Parthenon, is convex, and that the horizontal lines of the entablatures are nearly parallel to those of the stylobate.

The differences of level in the angles of this temple, which are not considerable, may perhaps have entirely resulted from disturbances caused by the earthquakes from which this building has suffered, as is clearly evidenced by dislocations in the drums of almost all the columns. These disturbances are especially remarkable in the north-west angle column, and it is this angle which falls most considerably below the average level. If any subsidence took place, it would be most likely to occur here, where the stylobate is raised to a greater height above the rock than elsewhere. An examination of the joints of the architrave also shows that this angle has slightly sunk with reference to the contiguous parts.

The other irregularities in the curvature may have arisen in some degree from the same cause, but probably in a still greater measure from the outward pressure of the vaulted roof over the cella, which, as before observed, by acting upon the walls and columns, has partially disturbed the blocks forming the stylobate at the base of the columns.²

Judging from the east front and south flank, which have been the least subject to derangement, the increment of curvature in the fronts appears to be one dactyl ($\frac{1}{720}$ of the breadth of the front very nearly). That on the flanks .105 (just $\frac{1}{1000}$ th part of the length). The increment in the entablature is about one fourth part less than that of the stylobate in the fronts, and one tenth part less in the flanks.

Among the principal proportions of the Theseum may be mentioned—the breadth of the abacus of the columns of the eastern portico, exactly $\frac{1}{12}$ of the breadth of the front (for it measures 3.75, and $\frac{45.011}{12} = 3.751$), and the height of the columns, exactly five times this abacus; for $3.751 \times 5 = 18.755$, the average height of the angle columns being 18.747.

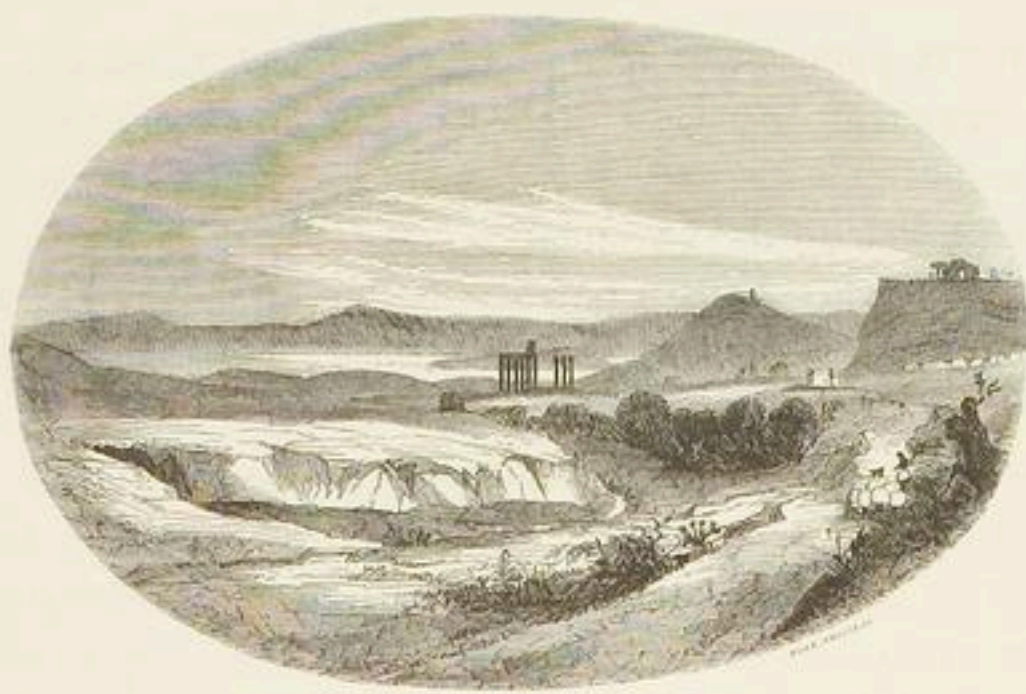
The abaci of the columns of the north and south flanks are 3.74 in breadth. Those of the west front 3.78. In the former the difference of dimension with the capitals of the east front is unimportant. In the latter probably it had some signification. The abaci of the four angle columns are 3.855 in breadth.

The above notices of the construction and proportions of the Theseum will suffice to show its general analogy with the Parthenon.

¹ The measurements of this curve, given in the Plate XXXV., upon the upper bed of the raking cornice would indicate an increment of .072 in 24.3 feet. Although the curvature on all the finished lines was distinctly visible when the eye was placed in the proper position, I was satisfied that it was not nearly so great as on the rough and weather-worn surface on which the measurements were taken. This was the only line, however, which could readily be measured, and want of time prevented my obtaining the amount more satisfactorily.

² The disturbance would be exhibited more at the circumference than at the centres of the columns. Accordingly, we find that the dotted line supposed to pass through the centres of the columns is tolerably regular.

It is impossible to say whether any movement is now taking place owing to this outward pressure; but it is much to be wished that the vault should be secured by iron ties, as in the event of the shock of an earthquake its additional action might be very injurious to the building.



CHAPTER XII

SECTION I

ON THE TEMPLE OF JUPITER OLYMPIUS AT ATHENS

PLATES XXXVII. XXXVIII. XXXIX.

ALTHOUGH the Corinthian order cannot in itself be compared in grandeur with the Doric, there is perhaps, nevertheless, among all the remains of antiquity no ruin more impressive than that composed by the gigantic columns of the Temple of Jupiter Olympius at Athens. The vignette at the head of the chapter represents the appearance of the temple from the upper course of the Ilissus.¹ The ruins stand quite alone, and although only sixteen columns are now standing out of the hundred and six which formed the porticoes and peristyles of the complete temple, yet their happy disposition conveys to the spectator no insignificant idea of the original dimensions of the building.

The completion of this great and almost mysterious structure² was long an object of ambition among some of the mightiest of the Pagan world during a period of 650 years. The work, begun by the Athenians in the first burst of their greatness, carried on by the Greek princes of Asia, and remaining still unaccomplished in the hands of the first emperor of Rome, was only perfected and dedicated under Hadrian, long after the worship of Jupiter had ceased to be real, and had already in great measure fallen into contempt.

The destruction of this temple probably commenced at an early period; as it does not appear to have suffered like the Parthenon from any sudden catastrophe, but to have supplied from time to time building materials to the inhabitants of Athens during the dark ages. Paganism at Athens seems rather to have been gradually supplanted than violently overthrown, and as many of the temples were converted into churches, it is to this circumstance chiefly that they owe their preservation. The Olympieum, however, does not seem to have been thus converted until the temple was reduced nearly to the state in which we now see it (see note 3 in the following page), and with the exception of the loss of one column destroyed about the year 1760, it seems to have suffered little or nothing during the last two centuries. The number of columns shown by Carrey is seventeen, and sixteen—including the prostrate column—now remain.

These columns, although their design and execution is not equal to the Greek workmanship of the time of Pericles, are nevertheless worthy of examination. Stuart was prevented by their height from measuring the capitals, and they have not been published by any of his followers. I succeeded in suspending a small scaffolding round one of the most perfect of the capitals of the external peristyle,

¹ This was the appearance of the temple in 1847—now modified by the loss of the middle of the three isolated columns overthrown by a storm in 1852, and by the increase of the modern town.

² Unum in terris inchoatum pro magnitudine Dei, Livy, 41, 26.

which enabled me to take the measurements and sketches from which the plates illustrative of these columns have been prepared.¹

Plate XXXVII. is devoted to the general dimensions of the column and the curvature of the entasis. For the better illustration of the latter, the shaft of the column is represented as turned round with respect to the base and capital $7\frac{1}{2}$ degrees, so as to present its full diameter; and a fillet has thus been brought under the centre of the capital, instead of a channel, which a correct elevation ought to have shown. The entasis has been already described in Chap. V. p. 43.

The columns are stouter than is usual in the Corinthian order, being only $8\frac{1}{2}$ diameters in height; or $8\frac{3}{4}$ including the plinth. According to Vitruvius the latter height should be $9\frac{3}{8}$ D.²

On the block plan, at the bottom of Plate XXXVIII., are given the differences of level observed in the stylobate; and similar differences in the architrave are noticed in a memorandum on the plate.

The marks on the top of the architrave stones, given in the middle of the plate, explain the manner in which they were hoisted by the instrument now known under the name of *lewis*; and how they were joined together horizontally by cramps, and vertically by stubs or dowells. It appears that the latter were run with lead from without after the frieze was hoisted into its place.

The architrave is generally built of three stones, but at the angle intercolumniations it is composed of two only, on account of the defective bearing which would otherwise have been introduced in the internal angle, both by weakness of the undercut abacus and the tapering of the mitre joint. One of these stones is the largest now found in construction at Athens, it weighs about 23 tons.³

The architrave externally is 4.1 high and of three fascias. On the inside it has two members. At the level of the moulding dividing these the entablature of the Pronaos was connected with that of the external peristyle by a beam 6.15 broad and about 13 feet long. No further details of the entablatures remain, except that some small cramp-marks on the exterior margin of the architrave seem to denote that the frieze was decorated with sculpture.

On the upper part of the plate is given an angular elevation of the capital, with measurements of the principal members.

Plate XXXIX. gives the plan, elevation, and section of one of the columns of the exterior peristyle.

These columns differ from those of the interior order only, I believe, in the variety of their bases, which are as given by Stuart. The measurements here given are confined to the columns of the external peristyle. The capitals differ among themselves in the form of the centre flower; two varieties which I observed are given in this and the previous plate. The foliage is boldly and effectively carved; the measurements, although not absolutely equal in similar parts, do not vary to so great an extent as to exert any appreciable influence on the view from below. The form of the cusps of the leaves is that of the earliest style of Greek Corinthian, as pointed out by Mr. Woods (II. 263). The profile of the astragal, and the convexity of the lower leaves at their springing, deserve to be noticed; as also the following peculiarity in the angles of the abacus as seen on the plan. The fillet dividing the torus from the cavetto is formed by a circular arc, each octant of the abacus being struck with a different centre; but the extreme or upper edge of the torus, which is concentric with the fillet till within about a foot from each angle, passes into a tangential straight line at that point, so as to converge more rapidly, and avoid that excessive acuteness of angle which may be observed in the stoa and gate of Hadrian at Athens, in the Temple of Vesta at Rome, and some other examples.

¹ This is not the only ascent on record of the remains of the Olympieum. In 1820 Mr. Lewis Vulliamy, Captain Jones, and Captain Stoddart, R.N., mounted to the top by means of a stone thrown over the architrave with a small line fastened to it, to which a stronger, and ultimately a rope-ladder were attached. I adopted the same method. A rope-ladder was supplied to me by the late Captain le Hardy, of H.M.S. *Fantome*, and hoisted under the direction of the Master, Mr. Batt. I was only able to effect the object I had in view after the small line had been several times cut in two whilst being drawn over the rough surface of the marble.

² By D the full lower diameter is intended. Vitruvius (IV. 1) defines the height of Corinthian columns as being $\frac{3}{2}$ D taller than Ionic. In the same chapter he assigns to the latter, according to the older editions, the height of $8\frac{1}{2}$ D, and according to the later, which I follow, 9 D. In Roman examples the height is often found to be 10 D, e.g. the columns of the Temple of Mars Ultor, which, although they are less in diameter than

those of the Olympieum (being exactly 6 Roman feet = 5.83), exceed them in height by about 3 feet.

³ The ruinous construction of rubble above the architrave of the two westernmost columns of the principal group, which at the same time adds so greatly to the picturesque appearance of the columns from a distance, seems to have belonged to a larger construction, occupying a considerable portion of the architrave, and connected perhaps with the church of St. John, *σταῖς κολώναις* shown by Carrey and Fanelli. The latter in his description of the ruins, page 329, says "Mentre oggi di sopra il grande architrave di quelle si vedono mure diroccate, ma in dieci piede di altezza" "Fra le sudette colonne si trova piccola chiesa Greca." The church is represented by Carrey as in ruins, and the rubble construction, above named, scarcely extending farther than at present. In Carrey's drawing also, the seventeenth column, which has since disappeared, is shown as having lost its capital. (Since the above was written the rubble masonry referred to has been taken down.)

The length of the radius forming the curved portion is equal to the breadth of the abacus. The great depth of the abacus is not displeasing when viewed from a proper distance.

The main proportions of the capital are as follows, in terms of the lower diameter—

Height of the capital	= D
Breadth of the abacus	= $\frac{4}{3} \times D$
Depth of do.	= $\frac{1}{6} \times D$
The upper diameter of the column	= $\frac{6}{7} \times D$
The height of the larger leaf	= $\frac{8}{15} D$

Or what amounts to the same thing, $\frac{2}{5}$ of the breadth of the abacus.

The height of the smaller leaf	= $\frac{2}{5} \times$ height of the larger leaf.
That of the cauliculæ	= $\frac{9}{10} \times$ height of the larger leaf.

SECTION II

JUPITER OLYMPIUS. PLATE XL.

THE remains above ground of this enormous temple have been described in the previous section of the chapter; but it seemed desirable to the Society that an attempt should be made to recover the internal disposition. I succeeded in 1883, through the kindness of the Prime Minister, M. Tricoupi, in getting permission to make some excavations for this purpose, the permission being afterwards renewed in 1885, and again in the spring of 1886. When the results of these researches had been plotted down, they appeared to confirm the then generally received opinion that the temple was decastyle, and which was also supported on very strong *à priori* grounds. It is true that some difficulties presented themselves, but they were at least equally shared by the octastyle theory. Dr. Dörpfeld, who had seen my drawings, took the latter view, and I was very glad of the opportunity of my residence in Athens as Director of the British Archæological School to make some further examination of the site at points specially adapted to resolve this question. The issue of these trials gave preponderating strength to the view that the temple was octastyle,¹ and a few more excavations at suitable points cleared up the difficulties I had before met with, and enabled the plan of the temple on all essential matters to be recovered. In addition to the foundations of the different parts of the temple built by Antiochus, some evidence of walls and pavements of a more ancient construction were found, which may naturally be referred to the time of Pisistratus, but there is also a wall, which will be described in its proper place, which appears to have been of a still earlier date.

At the commencement of the excavations the oblique trench shown on the plate, and commencing about 85 feet from the eastern stylobate, was cut and carried down to a depth of about 8 feet without finding anything until it struck the broad central wall marked by the letters A D F on the plan which extends for about 115 feet parallel in a general way, though not exactly so, to the lines of the temple. It is composed of blocks, generally $4.25 \times 2.17 \times 1.58$ deep, of reddish pudding stone, a material found near at hand and much used in constructions of a tolerably early period at Athens—for instance in the retaining wall which supports part of the Dionysiac Theatre—but very little, if at all, in later buildings. Working along the sides of this wall, other foundations of a different stone and of a different character of workmanship were discovered.

It was soon apparent that the remains were to be looked for at a much greater depth than that to which the first search trench had been carried, and consequently anything like a general continuous excavation would have proved too costly for our undertaking. The system of trial holes was therefore necessarily adopted, which were of course sometimes unproductive, but generally even from these something could be learnt by observing the character of the soil through which they were pierced.

In taking the measurements of the foundations that were discovered a theodolite was used, and the various points were referred to a distant object of which the position had been ascertained, as well as to some near convenient part of the existing structure, and from these data the dimensions, depths, and recorded angles were obtained by computation. Thus the disconnected position of the parts in the different cuttings was unimportant.

For the purpose of exhibiting the results of the excavations more in detail I have divided them into four separate groups on the plate, namely—Group *A*, which commences at the extreme east, and extends along the stylobate 80 feet westwards; Group *B*, extending about 100; and Group *C*, about 90 feet in the same direction; and finally *D*, reaching to the western extremity. The letters A B C, etc., in connection with the excavations themselves, indicate by reference to the tables on the margin the depths at which the various foundations or rock beds, etc., were found, or in the absence of these, the depth of the cuttings themselves. These measurements are in all cases

¹ Thus clearing up an obscure passage of Vitruvius, III. 2, "Sed Athenis octastylos et in templo Olympio," etc.

reckoned downwards, from the top of the plinth of the sixth column of the second row from the south. As the same letters have very nearly the same values in the different groups, the relative levels of the different portions of the foundation which remain can be inferred approximately by inspection of the letters only.

GROUP A.

Commencing with Group A and at the north-eastern point, and at the place where the angle column would have stood had the temple been decastyle, rough unprepared rock was found, and where the ninth row would have been, a narrow wall of rubble which formed one side of a drain external to the temple, of which drain there were additional traces in other places. Near this, but actually outside the limits of the plate, being 36 feet to the east and 8 feet north of the north-east angle of the stylobate, was a remnant of the original pavement 8.53 below the datum. Ranging with this level, but with a suitable allowance for *currenting*, the pavement was again found about 140 feet northward of this point at the entrance to the Peribolus (see woodcut 16), of which further mention will be made. It is also in exact agreement with the starting-point required for three steps, which we must suppose to have been equal in depth to the two existing upper steps of the stylobate on the south side; and the foundation marked K on the plan opposite the third column of the southern row would also be exactly suitable for such pavement. At O in the last-named cutting the excavation could not be carried deeper for fear of shaking the superstructure, but it showed that the two lower steps of the stylobate which had tailed into the wall had been cut away. They were formed of hard limestone, the upper step only being of marble. Some portions of the original pavement connected with the stylobate at the south-east angle are shown on the plate.

Returning to the north, we find a long range of foundation H H G laid in a direction parallel to the existing columns and generally about 16 feet wide, which extends with small interruption along the whole extent of the temple. It consists of large stones of irregular polygonal shape composed of hard limestone, fitted together but not jointed. The depth is variable, as dependent on the rock beneath. It is undoubtedly the foundation of the northern row of columns.¹ At the point O, about 54 feet from the eastern stylobate, the southern ledge of this foundation coincides with a piece of the natural rock, which was cut or chased in such a manner as to show that a return or cross wall about 8 feet thick ran southwards at that place. At two isolated pits, O and M respectively, about 20 and 50 feet to the southward, the wall was sought for, and although no stones were found the prepared bed on the rock was very evident, and on examining the side of the long cutting where the traces of this supposed 8-foot wall were seen, and looking southwards, the original orderly filling in was seen on each side of the space it had occupied, whilst over the site of the wall itself the ground had been tumbled in promiscuously by the searchers for building stone. The orderly filling in above mentioned extended to within about 10 feet from the eastern stylobate when ground of similar irregular character testified to the removal of the foundations of the east front. There could therefore be no doubt of the existence of a wall at the point indicated. It is evident that this wall did not show itself in the peristyles above the finished pavement, but was provided as a ground buttress in the continuation of the line of the front of the Pronaos.² (I found a trace of a similar underground wall at the point in Group C, marked by the letters X Q M, and also to some extent in the line between V and X, in Group D. It was not found under the peristyle on the line of the cross wall G N Q Q, etc., in Group B, but that wall is of itself so massive that it could scarcely have been thought necessary.) At the excavation marked J no foundation was found of any wall or column, but at the depth indicated a concreted layer about .6 thick laid on a bedding of stone chips covered the entire surface. There can be little doubt that this was formed in preparation for a pavement, but such pavement would have been much below that of the Temple of Antiochus.

¹ For reasons now quite unnecessary to dwell on, I was at first inclined to consider this foundation as that of the north cella wall.

² The discovery of this wall was one of the reasons alluded to in the

previous note, and seemed at first to favour the hypothesis that the main wall into which it had been bonded was the north wall of the cella and that this was the foundation of the Pronaos wall of a decastyle temple.

GROUP B.

In the northern part of the temple throughout this group is the continuation of the broad polygonal work, and there remain upon it two squared stones of an upper bed of softer stone called poros,¹ marked G and H, and near them lie two large displaced marble blocks which evidently had belonged to the upper step of the stylobate. A little to the southward is a foundation about $9\frac{1}{2}$ feet broad, partly excavated in the rock and partly built of polygonal blocks; see the letters PPK on the plate; and again south of this is a wall GNTV of squared stones built up against the wall of red pudding stone ADF already mentioned, and also overlapping its eastern end. It should be noticed that the overlapping portion NQQ was built of poros stones which had been removed from some other and more carefully built structure, and used up again here with less consideration for the joints. On this floor lay two large marble blocks which seem to have fallen from the upper parts of the temple; one of them is engraved in Fig. 13, page 84. At UQ, near the last mentioned, and on part of the first trial cutting, but at a much greater depth, was a wall of carefully jointed and squared masonry two courses high of poros stone. It appears to belong to a different period to that of the existing temple, to the lines of which its face and joints are decidedly oblique.² At V, to the south of these stones, the rock-bed prepared for the cella wall was evident, but the stones had been removed. In the cutting marked Y no stones remained, but two traces of walls, one of which the northern edge was 25.80 distant from the line, to which most of the north and south measurements are referred, and another about 4 feet farther north. The former would accord with one of the walls of the work of Antiochus, and the other line is in continuation of the oblique wall which will be described under Group C. A little south of the wall ADF where marked XN was a concreted layer similar to that described at J in Group A, except that this was about a foot lower down. This same layer N was traced farther west and south (a trace of it had also been noticed about 44 feet to the east of the point now under consideration). It seemed to have been cut off parallel to the wall ADF for the eastern part of the length at a distance of about 5 feet, but for the remainder only about .6 foot. At the point E at the eastern extremity of this group it was judged unnecessary to sink to any depth, as it was clear from the nature of the ground cut through that none of the foundations of the temple could have been there.

GROUP C.

Search had been made in the northern part at SXR for foundations on the decastyle hypothesis.

At T a sinking was met with in a mass of hard rubble, which was afterwards identified as the drain. At R a building stone was discovered, but not *in situ*. The ground had evidently been ransacked, and the results here obtained were inconclusive.

The broad 16-foot wall of polygonal stones runs east and west through this group. To the south of this wall are some foundations QMUR' composed of squared poros stones. The direction of the joints of these shows that they belong to the same construction as the oblique walling already noticed. At the western end, however, between Q and X' this work has been cut off and finished by a wall of which the western face was traced going southwards and built square with the existing temple. A little to the south the oblique work of jointed stones was again found both with a western and a southern face VV, also the very rough termination of the wall ADF.

At Q was another thin layer of concreted work similar to those already mentioned, but at a somewhat lower level. Of the three stones of the south-westerly cutting VY of this group, two of them showed a face westwards, and had the characteristics of the oblique work; but the irregularly shaped stone which connected them with the foundations of the south cella wall was of the hard limestone, and resembled the polygonal work.

¹ Elsewhere called Piræic.

² The obliquity measured here appeared to be $2^{\circ} 45'$.

The south-east portion of this group was very interesting. Nearest the surface came a mass CC, at its western extension certainly of mediæval rubble, as evidenced by the character of the pottery found in it, and from some parts of it being founded on blocks of marble and of stone which had fallen from the temple. A distinct portion of it, which has been defined by the nearly square outline in the plate, may have been older, and was founded on the concreted layer NN mentioned in Group B, and occupied the lines of its western and southern limit.¹ To the south of this rubble work was an extensive piece of carefully squared masonry of the poros stone U'U'W, of which the southern face had been here and there bonded into the cella wall, the stones of which had been pulled away from it. The faces and joints of this wall were unquestionably oblique to the temple. The angle measured from this face was $2^{\circ} 20'$; but if taken in combination with other traces of the same wall it is somewhat reduced, but certainly amounted to more than 2° . The careful character of this poros stone work, and which invariably, wherever found, both in its joints and faces, show this want of parallelism with the Temple of Antiochus, cannot fail to point it out as the work of another epoch.² By the south side of the oblique wall was the rock-bed from which the cella wall had been uprooted, and there was distinct evidence that this cella wall had been built later than the oblique wall.

The oblique wall butts against a rough wall PPT of hard limestone, which has every appearance of being of more ancient masonry, and there are signs of the oblique wall having been originally continued eastwards on the other side of the wall PPT, and indeed as far as the next cutting Y, but no stones were found. The rough wall just referred to was traced from ADF, which wall is partly built over it, to the foundations of one of the columns of the second row from the south. Both from its character and position it is clearly the most ancient of all the remains that were discovered, and if we assign, as I think we fairly may, the foundations parallel to the existing temple to the work of Antiochus and the oblique walls to Pisistratus, this must belong to the still earlier foundation which was by tradition attributed to Deucalion. The concreted layer N was found resting on and at first concealing the top of this wall.

During the spring of 1886 the foundation of the eastern of the two isolated standing columns (the fourteenth from the east end) was examined by the Athenian Archæological Society that the sufficiency of its foundations might be ascertained,³ and it was found, as represented in the section (see woodcut Fig. 14), that it rested on five circular drums, unfluted, of poros stone, about 2 feet thick and more than 8 feet in diameter, which were probably drums prepared by Pisistratus for a Doric temple. Near the small Propylæa (see woodcut Fig. 16) lie a number of pieces of drums of large diameter, one of which originally measured 7.82.

GROUP D.

At the north-western portion of this area, at P', the position due to a column on the decastyle theory, nothing was found beyond some rather loose rubble suited to carry a pavement. South of this was the drain already noticed in Groups A and C. It received a drain which passed along the west front of the temple, and then carried off the water in a westerly direction.

At P a wall of five courses of masonry rising from the rock Y gave clear evidence of the foundation of the northern flank of the octastyle temple. The stones resembled the polygonal work which had been found at nearly the same level all along the flank. At V was a stone which might have belonged either to the northern flank or to the inside of the cross wall of the Posticum; but the bed worked on the rock at X, which could only have been prepared for the latter, is more decisive. The conclusion that the foundation of the Posticum wall was here is further strengthened by the isolated foundation of the column B; which was found very near the surface; from which it follows

¹ An imperfect bronze vase was found in connection with this part of the rubble work.

² There were no deviations from parallelism at all commensurate with these in any of the other foundations.

³ I had represented to the Society that it was not unlikely that the destruction of the sixteenth column by the storm of October 1852, might have been due to its foundations having been undermined by the mediæval stone searchers, and that it would be wise to examine the supports of the other isolated columns.

that, as at the east end, there were here three rows of detached columns in front of the wall. Whether or no there was a western door to the Posticum I obtained no evidence. At M, where search was made for another column, the excavation was hampered by the presence of a fallen frustum, and was discontinued. At O K L the extreme westerly extent of the temple was found with rough polygonal blocks extending to O, and beyond a prepared bed of rubble for the outer step, thus determining the number of columns on the flank to be twenty, as generally received. The confirmation, however, is valuable, as Stuart had at first maintained that the number was twenty-one. At M the search which had been commenced for the south-west angle column was discontinued when the limits above mentioned had been reached.

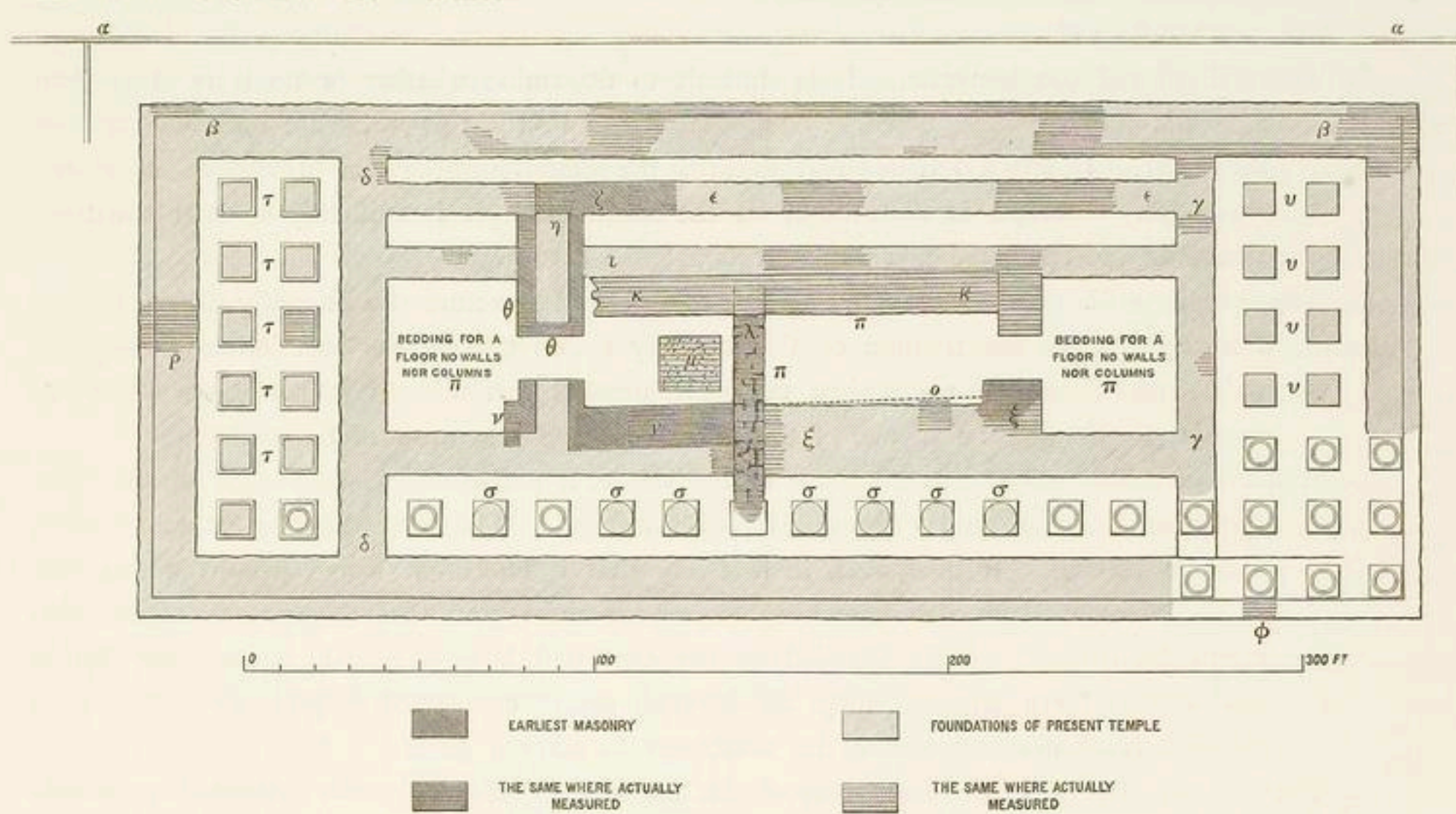


FIG. 11.

The object of woodcut Fig. 11 is to reduce to a simpler form all the results of the excavations. The different foundations are made out to the full extent that can be deduced from the parts actually examined, the latter being marked with a special tint; proper tints are also given to the works of older and later epochs.

- a. The drain which surrounded the temple; it is formed of rubble work, and the sides and bottom were coated with cement; it is about 1.2 foot wide.
- β. The foundation of the northern peristyle.
- γ. The eastern wall of the Pronaos. The foundation is that of a continuous wall, nevertheless the front of the Pronaos may have been prostyle, or with two columns in antis, resembling the arrangement at Branchidæ, which however had four columns between the antæ terminating the walls. There must either have been columns or a doorway, and the former seems the more probable.
- δ. The western or Posticum cross wall. As before observed no evidence was obtained as to whether there was a doorway in this wall. The Opisthodomus was entered by a door from the Naos at θ, thus following Vitruvius's description of hypæthral temples, "Aditus valvarum ex utrâque parte in pronao et postico,"¹ it would therefore seem most likely that the western wall was not pierced.
- ε. The foundation of the northern row of the second range of columns. For about half its length it was of the same quality of masonry as that of the outer row; but at about the point marked ζ it appeared to take advantage for some distance at least of the oblique foundations of which mention has been made in describing the groups, and which I refer to the time of Pisistratus.

¹ Vitruv., III. 2.

- η. At this point the oblique masonry appeared to have been stopped or cut off and intersected by a more recent wall built square with the temple, and which formed the western wall of the Naos.
- θ. A broad foundation of the oblique work which had been utilised for the wall last described, of which the southern face exactly ranges with the foundation laid for the northern door jamb at the east end of the Naos. It could therefore have been no other than that of a doorway into the Opisthodomus. The rock showed no sign of foundation south of θ for about 14.75 feet. At about that distance the character of the filling in showed that some work had been uprooted.
- ι. The north cella wall.
- κ. The wall of red conglomerate. It is difficult to determine whether or no it is older than the cella wall ι. It is nowhere bonded into it, but the two walls are built one against the other. It has a finished end towards the east, but seems as if broken off at the west end. The face is very rough on the south side; it is evidently of later construction than the concreted layer π.
- λ. The rough wall which may have belonged to the structure traditionally attributed to Deucalion. The construction of the masonry shows that it was anterior to the oblique wall ν, and it underlies κ, and at the southernmost part where it was laid open helps to support the foundation of one of the columns of the inner row of the peristyle.
- μ. A mass of rubble, apparently the base of the statue, a portion of it, westwards of the lines shown on the plate and woodcut, is mediæval work. The rest, which is extremely hard, may be Roman. If mediæval, it is likely that it took that shape from the fact that an older construction was known to have been there, and that therefore the foundation might be trusted. It is founded on the concreted layer π, of which some description has already been given, which, as it was firmly compacted, would no doubt have satisfied Hadrian's workmen of its sufficiency to carry a statue.
- ν. The oblique wall described in Group C; it appears to have originally extended eastwards beyond λ as far as the Pronaos door jamb, where part of it still remains, but the greater part between that point and λ was taken up by the later builders, and was used in other parts of the temple as already mentioned. The new wall required for the south row of the columns of the Naos was built parallel to the existing architecture, and a little further south. The oblique walling was not, I think, carried farther east than the stones shown on the plate.
- ξ. The south cella wall and the south-eastern parts of the Naos. The cella wall itself has been most effectually uprooted, but in one place the section of the cutting by the character of the filling in showed within small limits its original size, and traces of its rock-bed were found in several places. It may perhaps be inferred from one stone already mentioned that it was in part at least formed of the polygonal blocks of hard limestone.
- ο. The point where the maximum divergence between the trace of the oblique walling and the newer construction was noticed, amounting to nearly 4 feet.
- π. The layers of concreted work occupying three somewhat different levels in the central, eastern, and western divisions of the plan. The pavements for which they were no doubt prepared could in no place have been less than 6 feet below the floor of the existing peristyle. Above this layer was found usually several feet of carefully made ground of the Antiochian period, so that we must assign the layers themselves to an earlier epoch. The three levels observed are conformable to the natural fall of the ground.¹ It seemed probable that, as respects the central layer (marked N on the plate), its original western and southern limits were found, but its northern extension had been cut to form the trench for building the wall ι. By the two excavations in the Pronaos and Opisthodomus it was ascertained that no columns could have been built

¹ At Branchidae there is a descent from the Pronaos into the Naos.

for the support of a roof in these parts, as their foundations, or the traces of them if they had existed, must have been met with.

ρ . This part has been sufficiently described already in Group *D*.

σ . The foundations of these columns are supposed to be analogous to that which has already been described at the end of Group *C*, and it is easy to see why the inner range of columns to the north should be built on a continuous wall, but the southern and western on isolated piers, because the rock lies much deeper down in those parts, and the construction would be suggested by economy of material. At the same time it is to be observed that in neither of the excavations showing isolated supports was the rock itself reached, and there may have been a continuous bed one or two courses thick below the piers.

τ and ν show the foundations of columns which may or may not have been isolated. The enquiry is of little importance.

ϕ , as already stated, was found to have been exactly analogous to ρ .

The foundations shown in the above figure as either found or necessarily inferred fully account for all the parts in the Temple of Antiochus, excepting as to the questions above noted as to the columnar character of the Pronaos, and whether there was a western door into the Posticum. I incline to the affirmative as to the first, but to the contrary as to the second.

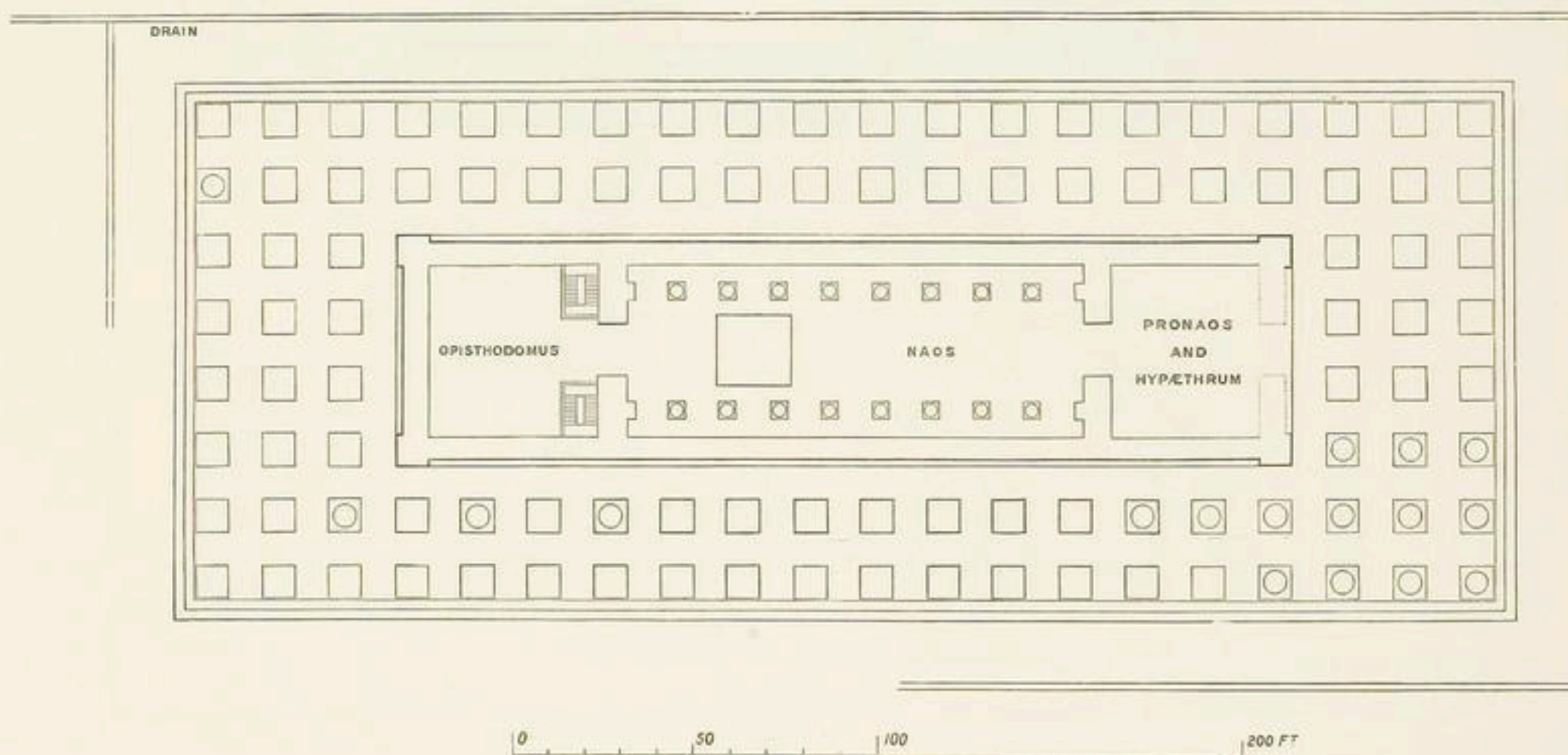


FIG. 12.

As respects the plan of the Temple of Pisistratus, the excavations only supply slight data. It is not unlikely that we have enough to show the extent of the Naos, about 116 feet long $\times$ 50 wide; the masonry *UQ* in Group *B* (see Plate *XL*.) marking the south-eastern, and that about *VYV* in Group *C* the western limit—the north and south extension lying between *UR* and *WU'* of the same group. We have also approximately the diameter of the columns and the level of the pavement. Anything beyond this would be mere speculation, but there can be no doubt that a great deal had been prepared, and that as left by the Pisistratidæ it was a very imposing mass.

The question naturally arises, Why was the orientation of the temple changed? I think the answer to this must be sought for in the extreme accuracy with respect to the cardinal points that the present temple exhibits. The difference is less than $0^\circ 4'$,¹ and a nearer approach to exactness without modern appliances would have been impossible. We may assume that it was thought by Antiochus a matter of principle that the Temple of Jupiter should have no bias either north or south.

¹ Four theodolite observations of Arcturus, agreeing well together, determined this angle as $0^\circ 3' 48''$. The axis of the temple, looking from east to west, being so much to the north of the true west. It may be observed that if the ancients in obtaining this meridian had used the usual method of

working by the sun's shadow, but neglected its change of declination between the morning and afternoon of the same day, at certain seasons of the year it might have led to a greater error than this.

Woodcut Fig. 12 gives a restored plan of the temple based upon the discovered foundations. The number of columns in the Naos is hypothetical, but I think good grounds could be advanced for the number shown, which gives a columniation of three diameters, as well as other very plausible proportions. The staircases shown in the Opisthodomus are imaginary, but some such staircases, of which there are several examples in Greek temples, would have been required, and the place suggested for them would have been convenient, and a foundation suitable for one of the two, namely that on the south side, still remains. We may conclude that the Opisthodomus was covered with a ceiling supported from the walls, which in an apartment not exceeding 46 feet square would not have been difficult, but that the eastern compartment was more or less open to the sky.

From the passage in Vitruvius in which he mentions hypæthral temples,¹ it might be supposed that the Naos itself was "sub divo et sine tecto" (as indeed it appears actually to have been at Branchidæ), and it is possible that it may even have been so in the time of Vitruvius; but when the Chryselephantine statue was dedicated by Hadrian it must have been protected from the weather, and as respects the lighting of the statue, nothing could have been more advantageous for this purpose than the high light admitted through a great window, such as is represented in the woodcut Fig. 14.

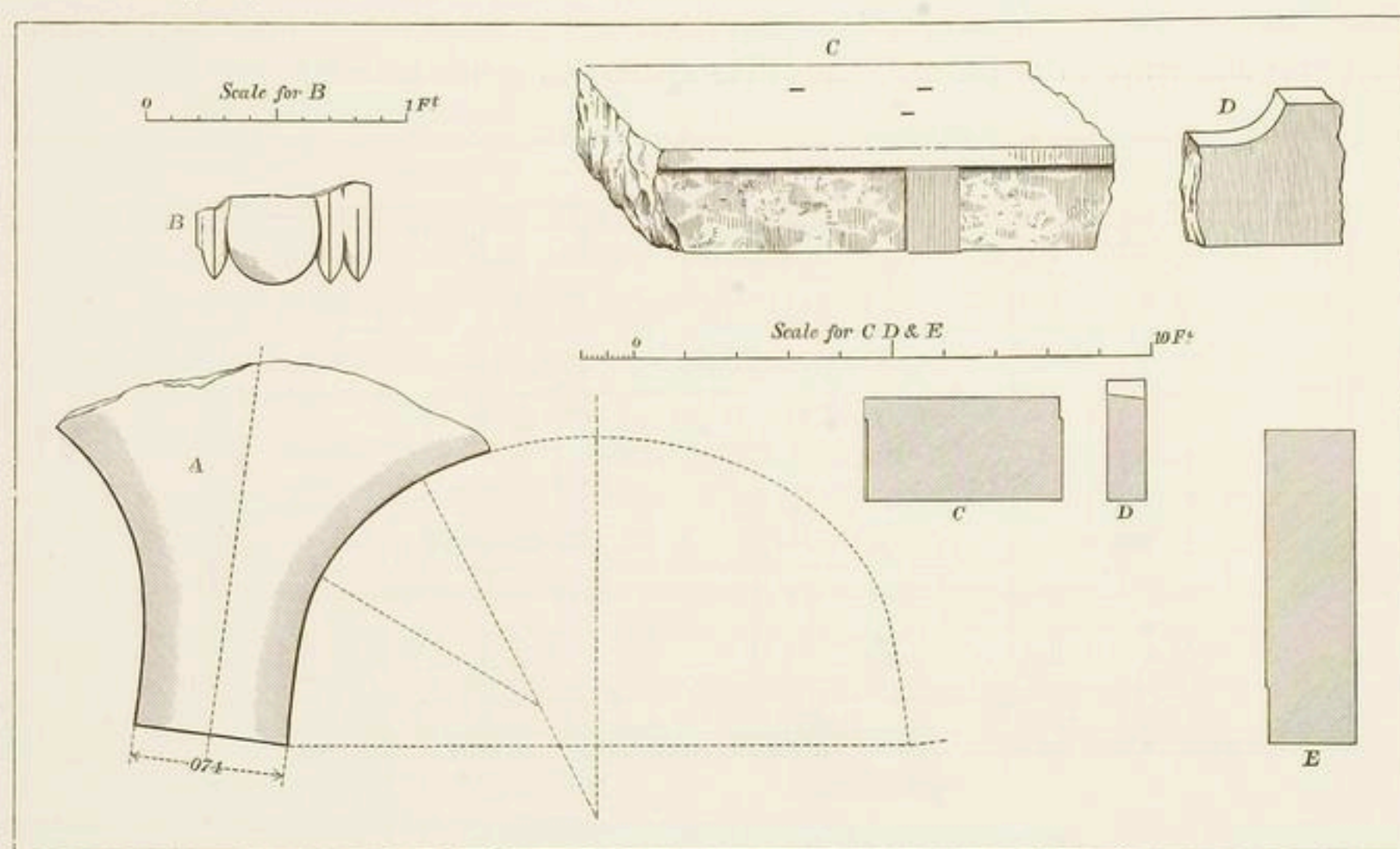


FIG. 13.

The two stones mentioned in Group B as having been found at Q Q, one of which is represented in the preceding woodcut, seem to have formed the floor of a kind of *triforium* connected with the entablature of the Naos columns. The stones were carefully jointed, and had *joggles* or keys worked upon them for making a firm and close connection. There were also cramp holes, suggestive of a course of slabs of pavement or roofing on their upper surface. The length may easily have been sufficient for the work assigned to them, for although broken at both ends one still retains a length of 8.8 feet. A portion of a stone of the same description was found near the western end of the red wall A D F, lying on the stones belonging to the Opisthodonius door-jamb.

Excepting the two stones just referred to, and drums from the columns of the peristyle and pieces of foliage from the capitals, remarkably few architectural fragments were found. One or two specimens of a rather large carved bead, possibly belonging to the lacunaria, engraved in woodcut 13; a few blocks of the cella wall, measuring $3.52 \times 2.52 \times 2.01$ deep, found near T in Group B and near U' in Group C; one piece apparently of the orthostatæ of the inside of the cella wall, found near U' in Group C; and the stylobate courses mentioned in Group B near G, form nearly the entire list,² but there

¹ III. 2.

² Amongst the few objects found which are worth mentioning were a well-preserved bronze medal of Caracalla, the imperfect vase spoken of under Group C, note 1, and three spikes of lead resembling nails, one of which

was perfect and had a well-formed nail-head, and was about half a foot in length. They were found lying upon the pavement bed, which has been attributed to Pisistratus. It is difficult to assign any use for them, unless they were prepared as models for nails to be made of harder material.

was one other fragment demanding special mention, namely the piece of a marble flute shown in the woodcut. It came out of the excavation which brought to light the rough wall in the south-eastern part of Group C, and enables us to restore with very great probability the diameter of the columns of the interior of the Naos. The place where the fragment was found and the diameter resulting from its measurement are both favourable to this hypothesis. That only one such fragment was found does not discredit it. Other small splinters of these columns may easily have escaped observation, and, as already mentioned, wrought fragments of any kind were remarkably scarce. The measurement I obtain from this flute at the point where it was broken off is a diameter of 2.91,¹ but as in the short length which could be measured the diminution was rather rapid, it is reasonable to suppose it was near the upper diameter, and at least an eighth part should be added, making it 3.27 at the lower diameter, or perhaps a trifle more.

It may be reasonably concluded that the Pentelic marble columns, of which the diameters have been deduced as above, and which in Fig. 14 have been shown as mounted on pedestals after the fashion of Roman times, did not form part of the grand design of Cossutius, but that the columns contemplated by him were monoliths, and were very likely provided but not placed when they were plundered by Sylla; and we may presume that those finally erected were the work of Hadrian.

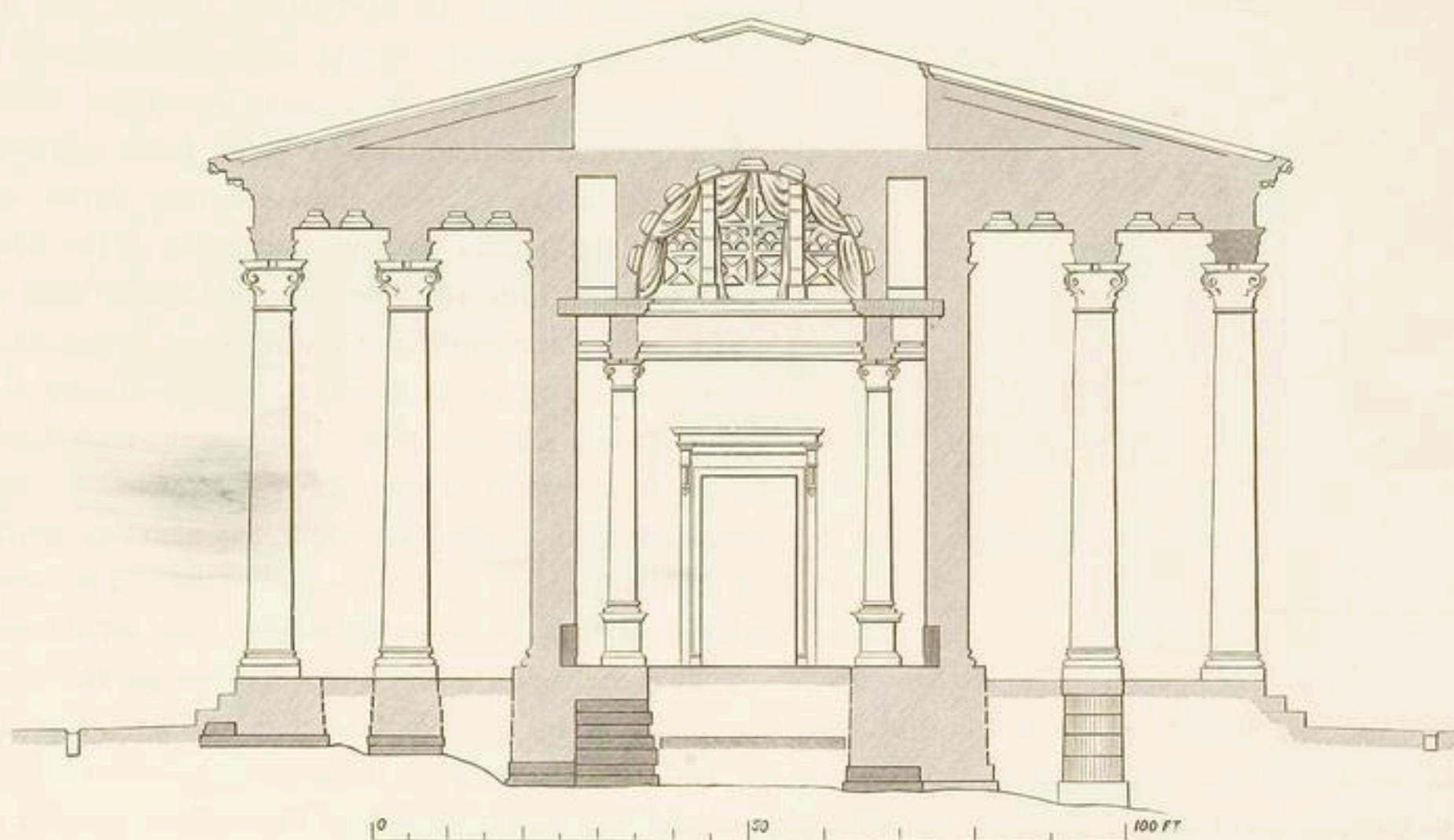


FIG. 14.

In agreement with Mr. Fergusson² I have supposed the Naos covered with a timber-vaulted and panelled roof and lighted from the hypæthrum beyond (which may have been either open to the sky for its whole extent or the open part restricted to two large skylights, allowing of a continuous roof ridge as suggested in the woodcut). The light from the hypæthrum is supposed to enter the Naos through a window equal the whole semicircular end of the vaulting. This aperture would probably have been divided by some kind of tracery or pattern-work and closed at pleasure with curtains or shutters, access being easily obtained from the western staircases along the galleries shown in the section. This arrangement seems both conformable to the hints given by classical authors on the subject of the *opaion*, and some such contrivance would have been imperatively called for by the variations to which the climate of Athens is subject.

Judging from the analogy of other Greek works and from the fact that, as already shown (page 27), the optical corrections have been considered in this temple, it is not to be doubted that in its plan and elevation it must have exhibited numerous simple proportions. Owing to its ruined

¹ Two methods offer themselves for this calculation. By one the fragment of the flute is restored on paper, giving it the usual proportion of depth and breadth, and from this the diameter is derived. By the other the fillet of the flute is compared with others of similar character so

that the breadth of the fillet gives a measure of the diameter. The first method gives 2.85 for the resulting diameter, the second 2.97.

² *The Parthenon*, by James Fergusson; 4to, Murray, 1883, p. 76.

state very little can be recovered. A prime proportion is generally, I might say invariably, found between the length and breadth, usually, but not always, on the upper step. Here, as in the Theseum, we must look for it on the lower. The total length on the upper step being 353.90 and the breadth 135.07, add to each for the projection of the steps 10.55, which would make the steps in good proportion, each being 5:4 of the height, and also be in accordance with the extent of the foundations at ρ and ϕ . Fig. 11,¹ with these projections added we obtain for flank and front the proportion of 5:2. The other general proportions of the plan were of course very much determined by the *pariquadrato* disposition of the columns, but probably the desire to secure an exact proportion of length to breadth led to the small difference observable between the intercolumniations of the front and flank.

Although no part of the entablature of the external columns was found in the excavations, there are some fragments in other parts of Athens which can originally have belonged to no other monument. I noticed three such fragments on the Acropolis, which must have been conveyed there as building stone, and one of them supplies an important part of the cornice, as shown in the subjoined woodcut.

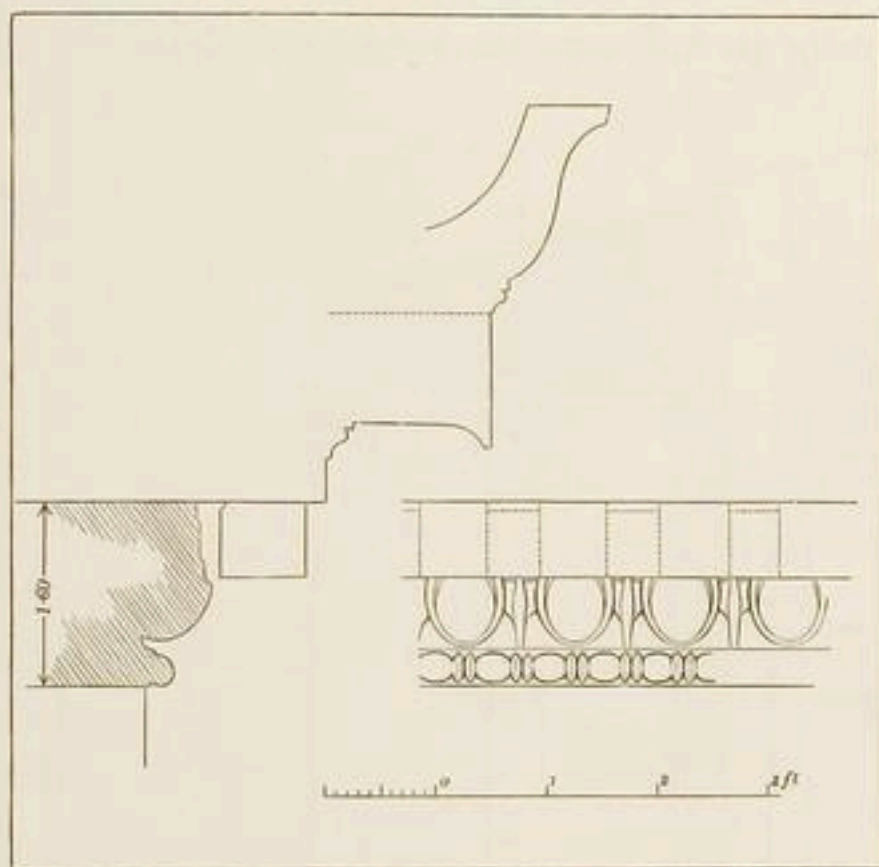


FIG. 15.

The remaining parts of the cornice have been supplied from the analogy of the mausoleum at Halicarnassus, and the temples at Ephesus, Priene, and the Smintheum.² For the height of the entablature, in the absence of contemporaneous Corinthian detail, recourse must be had to the great Ionic examples mentioned above. From these we may derive the height of the cornice as 5.16, the height of the frieze 3.31, making with the known architrave a total of 12.62 or two diameters, and the steps are known, their sum being equal to one diameter. The pediment at a usual pitch would rise 16.90. So that the total height of the front would become 91.05, a dimension which is exactly $\frac{2}{3}$ ths of the total width, and also one-quarter of the total length on the bottom step. The *order*, which consists of the column and the entablature, would equal half the width of the front on the upper

step; and the height of the column, without its plinth, is to the complement of the height of the front as 10 to 7. Besides these proportions we find that a group of three columns—that is, one diameter and two columniations—is immediately proportional to the height of the column without its plinth,³ namely, as 4 to 5. The breadth of the abacus is one-sixteenth part of 135.07, the octastyle front, and the lower diameter of the column $\frac{2}{3}$ th of the abacus. Compare Appendix, Art. 1. p. 112 *seq.* It will be seen that the above comprise some of the most important of the rules of proportion established by Mr. Lloyd. Stuart has shown a difference between the diameters of the outer and inner colonnades. This I did not find to be the case. But he has rightly marked the peculiarity of the bases, which differ much in height, the outer measuring 3.40 and the inner 3.84.

It has been shown in page 79 that the foundation of the southern row of the internal columns was re-built several feet to the south of an older wall which had been removed, and that the red conglomerate wall on the opposite side was built about 5 feet northwards of a line which terminates the concreted pavement bed of earlier date. We may fairly suppose that this line also marks the position of an original wall; and it seems reasonable to conclude that these two alterations belong to one and the same operation, the object of which was to widen the Naos; and it is probable that this preparation was the work of Cossutius, although the superstructure may have been built by Hadrian.

The cramped width of the Naos has been the main, although not the only, argument in favour

¹ The same dimension can also be deduced from the excavation near the north-east angle.

² A similar fragment had been used in an early church, now taken down, which stood within the inclosure of the Stoa of Hadrian. The dentils shown by dotted lines are imaginary. If they did not exist, the specimens

must have belonged to the pediment—following in this the analogy of Priene, where in the pediment the eggs were surmounted by a plain band; and a deeper dentil band would here suit the horizontal cornice better.

³ $2 \times 18.168 + 6.320 = 42.656$ and $\frac{2}{3} 53.58 = 42.864$, proportions with which we may be satisfied as sufficiently exact, the others however are closer.

of the decastyle theory; and it has been suggested that although the excavations may leave no doubt of the octastyle completion of the temple, yet that Antiochus may have intended it to be decastyle, and that the narrower width was subsequently adopted for the sake of economy. The remains, however, do not support this view. The foundations of the eighth row of columns are identical in character and material with those of the southern and western main stylobates, and in their whole width were built at one time; and there was no sign of preparation for anything except pavement and drainage to the north of them. Moreover, the octastyle arrangement, however unfavourable it might be to the grandeur of the Naos, would have produced a far better proportion in the fronts than the other. The great width of a decastyle portico would have demanded loftier columns than those which were built; and there is sufficient evidence for attributing the existing columns to Cossutius.

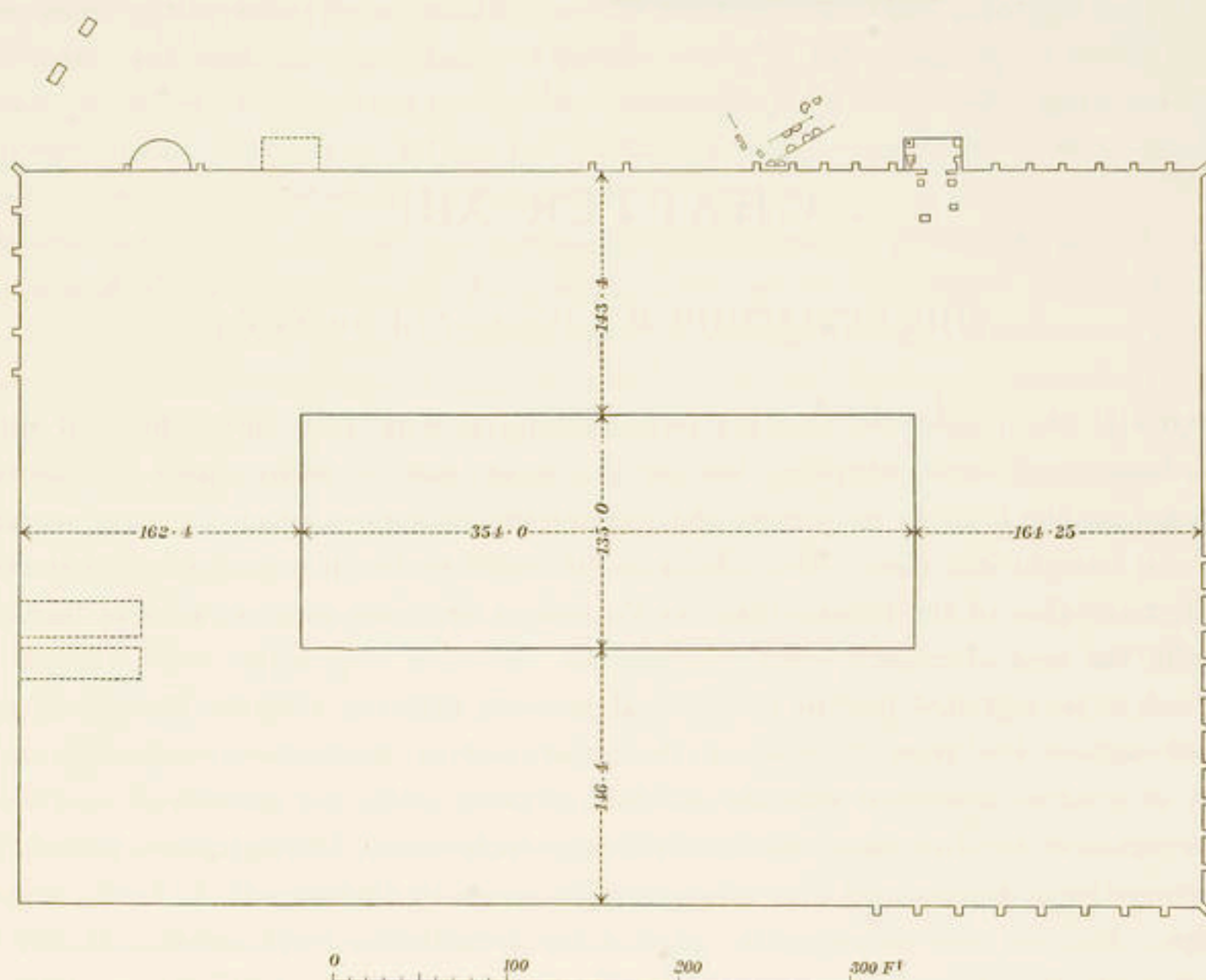
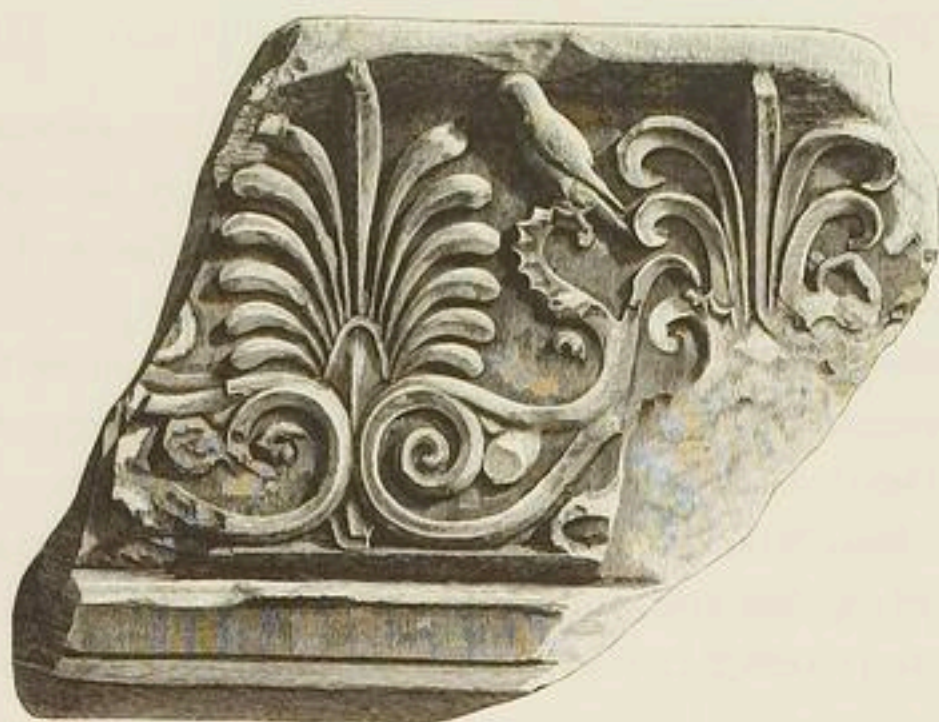


FIG. 16.

Some additional knowledge has been lately obtained respecting the Peribolus, where a small Propylaea has been discovered on the north side, and near the line of the eastern front of the temple produced. Close by are the remains of three of the pedestals of the numerous statues which were erected in honour of Hadrian.¹ There was doubtless another similar entrance ranging with the western front of the temple, but it has entirely disappeared. The semicircular foundation near the north-west corner of the Peribolus seems to be of late Roman work, and may have been the base of a bastion erected in the reign of the Emperor Valerian, when the fortifications of Athens were strengthened, for the purpose of utilizing the massive walls of the Peribolus for the purposes of defence. Two extensive vaults of Roman construction extend under the Peribolus near its south-western angle.

¹ From some further excavations lately made on the south side of the north wall of the Peribolus, it would seem that bases of pedestals were arranged along the side of the wall at intervals of about sixteen feet from one another. As the total circuit of the Peribolus is nearly 2400 feet, some idea can be formed of the number of statues which were dedicated to Hadrian by the gratitude of the Greek cities.



CHAPTER XIII

THE ERECHTHEUM. PLATES XLI. TO XLV.

ALTHOUGH the Erechtheum did not form an integral part of the first edition of this work, it is a building of such surpassing interest and beauty that no apology need be offered for now including some account of it in its present state, and of the indications which the more recent clearing of the site have brought into view. The subject is illustrated by five plates, a plan, and three sections, and also a restored plan of the temple (Plate XLV.), and on the same plate are some further particulars connected with the west elevation.

It is much to be regretted that in the interval between 1847 and 1883 the remains of the temple have suffered serious loss from the fall of the upper part of the western wall, with its peculiar arrangement of windows combined with the attached columns. Also the remains of bases of pilasters on the westernmost of the two cross walls are no longer to be seen. I have restored these bases on the plan and sections from sketches and dimensions supplied to me by Professor H. T. Lewis, who measured them in 1842. They are also shown on the plan of the Erechtheum by M. Tetaz.¹ It will be shown further on, however, that there is reason to doubt whether these windows and pilasters formed part of the original construction of the temple. The removal of encumbrances, however, has exhibited several points not visible at the time referred to, and particularly as to the arrangements at the base of the western wall. It is evident that here we have some remains of an earlier structure upon which the existing temple was founded, one of the oblique joints of the earlier temple extends into the threshold of the small doorway leading from the north portico and shows itself upon the surface. Other stones, both marble and poros, having the same parallel direction in their joints were covered up and were merely used as foundation. The angle between the older and the more recent structures is about $13^{\circ}.30'$. The drain, which discharged water from the western area by means of a pipe carried through the middle step of the north portico, is shown on the plan, Plate XLI. (see also Plate XLIII.)²

Unlike the rest of the Erechtheum, the west wall has no moulded plinth, but the *orthostata* rise at once from a double step, of which the lower has been hacked away. These steps, however, do not appear to have extended to the south of the doorway in the western wall, as the projection, of which a small portion remains on the south side of this door, has a different section and projects only .34, whilst in depth it is equal to the double step; and, judging from its jointed side on the south, seems to have been continued farther in that direction originally. It should be noticed that this doorway is not in the centre of the wall, nor is it symmetrically placed with respect to the attached columns. The sill is slightly below the top of the lower of the two steps. On the outer face of the wall, below it and to the

¹ *Révue Archéologique*, Paris, Leleux, 1853.

² This drain was first noticed by Herr Karl Bötticher, *Untersuchungen*, etc. Herr Bötticher also thought he had discovered the foundation of a wall about 7 or 8 feet southwards of the drain, and which abutted obliquely

against the west wall of the Erechtheum. I was enabled, however, to examine the ground underneath the stones he refers to, and found them to have only such foundations as would be suitable for pavement, neither could I find the trace or mark of any such wall upon the west front of the temple.

right hand, are sinkings as if made for the insertion of steps descending towards the right. In the foundation of this part of the wall marble is used, but the courses which range to the left hand of the doorway, and which were no doubt covered by the pavement, are of poros stone. The doorway is covered by a massive lintel on which is a trace, shown in dotted lines on the plate, partly flat and partly sloping, as of some kind of roof or beam which lay against the wall, but was not chased into it. Under the central statue of the south or Caryatid portico the rough retaining wall, composed of blocks of the local rock, and which has been shown to be the sub-basement of the temple which in Chap. I. Sect. II. has been named the Cecropium, intersects and indeed passes under the wall of the portico. At this point about 10 feet of the lower courses of the western wall of the temple have been destroyed and rebuilt with more modern material. Above this one enormous stone nearly 15 feet long and 5 feet deep occupies the depth of several ordinary courses, and can hardly have been placed there without some purpose. It could not have been the lintel of a door of access to the south portico, as an examination of its interior will show (see Plate XLIV.), indeed the rough wall mentioned above runs completely under the portico and occupies almost all the space where the entrance would have been. A suggestion respecting the purpose of this stone will be offered at the end of the chapter.

By reference to Plate XLII. it will be seen that against the podium of the south portico, and founded on the rough wall already mentioned, is the trace of a thin screen wall which appears to have been combined with certain attached piers which would serve as buttresses to it.¹ Southwards of this screen the string of the podium is carved into the egg and tongue ornament; for the rest of its length it is plain. And of the engaged half columns which surmounted the west wall of the temple, the base of that nearest the south portico, together with the base of the adjacent anta, has been left unfinished and unchannelled on the upper torus. It is therefore evident that some roof or structure which has perished must have occupied the space where these mouldings have been so left.

It is remarkable too that the principal horizontal mouldings which now remain upon the western wall are not stopped nor returned in any way; for instance, both the cornice over the Caryatides and the podium string beneath them, and also the mouldings below the bases of the engaged columns, are cut off square at the lines of the main antæ of the front. The vertical lines of the antæ are carried down by a shallow vertical channel cut on the face of the great stone already mentioned.

Over a portion of the rubble work, towards the left hand of the front, is a projecting stone which served as a sort of pent-house roof over the small doorway which communicated with the north portico. The dotted lines underneath (Plate XLII.) show the depth at which the Neptunian marks (which will be described further on) are found; and to the left hand of the plate is a section of the coffered ceiling of the portico. This was evidently enriched with flowers or other ornaments of metal suspended through the holes pierced through the coffers.

The peculiar construction of the stylobate (Plate XLIII.) should be noticed, both the external steps being cut out of one stone and the combined thickness passing completely through the wall and extending to some considerable distance inside. The internal pavement was certainly at the level of the top of the lower of the two steps—so there was probably also an internal step against the wall. This step most likely extended along the whole width of the temple, but about 5.3 feet of its length has been entirely destroyed at the southern end. Also there is a bedding showing original toolmarks on each side of the western door and on the level of the pavement; so that the step at this part, if it existed, must have been distinct from the through wall stones. The large tank, which extends from the western wall to the western cross wall, has all the appearance of having been original, though it has been repaired and vaulted more recently; it probably received a great part of the rainwater from the temple roof, and would have supplied the water required for the garden of the Pandroseum. It does not seem necessary to look here for any connection between this tank and the Neptunian sea, which would be more conveniently filled from one near the eastern stylobate of the north portico. Marble slabs about 12 feet long and of the thickness of one of the steps would have sufficed for the pavement of this part of the temple and for the cover of the tank, and it is likely that the through stones above mentioned had some reference to the firm fixing of this pavement.

¹ The foundation of one of these piers remains on the rough wall adjoining the podium, and a detached bedding on the rock below, marked A on Plate XLII., was presumably in connection with them.

Six openings of the nature of doorways are still extant in and about the temple, namely, the great doorway from the north portico, the small opening in the same wall which led to the area to the west of the temple, the doorway through the west wall, that which led from the south portico into the temple, the small external doorway into the same portico from the east, and the low opening on the north side leading from the sub-basement of the temple to the Neptunian marks. There was also doubtless a large east door, and there must have been some others of internal communication—of two of the latter I think some traces may be indicated.

The opening of the great door from the north portico has been partly reduced in later times by the insertion of interior linings, which have reduced the opening from 7.95 to 6.83—measured at the bottom. I was permitted to remove some of the mediæval rubble for the purpose of examining the threshold, and found one of the original hinge sockets with marks of iron rust upon it. It is shown upon the plan (Plate XLI.) The jambs of this doorway incline inwards so as to reduce the opening at the top to 7.57, which gives an inclination of about 1 in 80 for each jamb. The height of the original opening of this doorway, 15.972, is very nearly twice the clear width. The external mouldings of this doorway are finely worked in marble;¹ the internal parts are quite rough, and were probably cased with metal. How the junction was made is concealed by the more modern casing. Of the small doorway contiguous to it the jambs are squared and finished, and there is no sign of there having been any additional ornamentation. The jambs of the doorway in the western wall are rough, and must have had linings. The hinge-sockets for folding-doors are still visible in the sill. The small doorway in the east wall of the south portico had for its sill the general plinth, with the exception of its upper torus, making a broad and high threshold, about 3.0 wide and 1.60 high, to be stepped over. The jambs seem to have had a finished marble surface. I could find no evidence of hinge-sockets, but the threshold had been much worn. The level of the floor inside the portico was .15 above that of the upper step, that is, the floor of the eastern portico. A steep staircase, of which some steps remain, and traces of others are seen upon the walls, led down from the floor of the south portico to the doorway which led into the westernmost division of the temple. Of the latter doorway the marble jambs on the porch side are finished on the top with a moulding which can now be traced only part of the way under the soffit of the lintel, but which originally was carried through and finished upon antæ having the small projection of .065 inside the temple. On the sill below are traces of hinge-sockets of the usual kind, but they are not original. The northern face of the lintel is recessed to the extent of about .5, giving evidence of some kind of ornamental head over the door. There are no marks very clear of fixing for marble or metal, and the appearances seem to favour the idea that this doorcase and head were of wood, doubtless richly ornamented.

With the exception of the great stone already referred to, the walls of the Caryatid portico are distinct from the main temple. The western wall shows a through joint from top to bottom, and the eastern wall is merely chased into the main cella wall to a depth of .080. The course of large stones forming the ceiling and roof has been inserted quite unconformably into the masonry of the cella wall (see Sect. Plate XLIV.), and it is pinned into the wall by a course .2 thick below and another about .16 thick above. To effect the insertion of this ceiling, of which the soffit is .12 below one of the ordinary beds of the cella wall, it was necessary to cut away so much of the top surface of a course of stones already fixed that in so doing the original cramps were cut away, as is shown by the traces of the lower part of the cramp holes which can still be seen. The cutting off square of the mouldings has already been noticed. These indications lead to the conclusion that this beautiful addition to the temple was not part of the original design, but was substituted—doubtless shortly afterwards—for some more simple portico when it appeared necessary to give more dignity to the side fronting the Parthenon. The marks of steps upon the walls already mentioned also give similar evidence; for besides the steps shown on the plan, which appear to have belonged to the final design, there are clear traces of another staircase which has been superseded.

The access to the Neptunian marks is a mere passage left through the wall for the use of

¹ The details of this doorway are well given in Donaldson's *Collection of Doorways*, 4to, London, 1833.

those who were connected with the temple. The western chamber of the main temple entered by the three doorways already described has a width of 12.85 feet, extending to a cross wall 2.17 thick. The foundation slab or sill of this wall, 2.45 wide, remains. This sill is of marble, and is founded on a wall of poros stone in four courses. The chases or toothings by which this wall was bonded into the main walls are very roughly worked, and do not appear to be of the original construction, also the joints and crampings of the sill itself are by no means of the finest workmanship, and taken in connection with the unsymmetrical manner in which it rests upon the poros foundation, and other marks upon the wall which will be further described, there appears, to say the least, a strong suspicion that the wall has been rebuilt in a position about 1.06 more westerly than its original place.¹ On the existing sill remains of pilasters, as already mentioned, were seen as late as 1846. Nothing can now be seen except the roughened bedding upon which they stood. These pilasters or doorjambs were not let into the cella walls, but must have merely rested against them. It will be seen in Plates XLIII. and XLIV. that by the side of each of the cross walls are some narrow channels about .3 in width and .013 in depth. Those adjoining the western cross wall could not be traced higher than the level of the string of the western wall, 12.72 feet above the floor. They can only be partially seen, as the walls have been much defaced. On the north side one of these channels may be distinctly seen at a distance of 16.09 from the western wall. There are also some traces, but not so clear, on the south side, where the wall has been more injured. The state of the cella wall adjoining the eastern of the two cross walls also admits of one only of these channels being seen—namely on the north side; neither can its original height be ascertained. All these channels were smoother than the general surface of the walls, and were not worked on the orthostatae. It will be found that they all occupy places analogous to the smooth margins which are so conspicuous in similar positions in the Propylæa. This remark, however, requires that the western cross wall should be shifted to the east 1.06 as already suggested.

The darkly shaded opening near the western cross wall (see Plate XLIII.) is the passage to the crypt and to the holes and fissures on the surface of the rock, which may be presumed to be those shown to Pausanias as *σημείον τῆς τριαιῆς*. These curious traces were discovered by M. Tetaz in 1846. They occur about 7 feet below the pavement of the north portico, and are shown on Plates XLI. XLII., and also on Plate XLVI. In describing these features it will be best to refer to the representation in the plate last named, which, however, does not pretend to accuracy as respects the architecture of the portico itself. They consist mainly of three holes, partly natural and partly cut in the rock; that lettered *a* is close to the eastern anta of the portico, is very irregular, and seems to form part of a natural fissure; *b* and *c* seem also near the surface to have been natural, but are hollowed out into a somewhat cylindrical shape between 2 and 3 feet deep and .8 or .9 in diameter; *d* is a receptacle, as may be presumed, for water, cut 1.0 deep in the rock, and connected with the holes *b* and *c* by means of a narrow channel, also about 1.0 deep. The channel is produced for a short distance in the direction of *a*, but was perhaps discontinued on its being discovered that owing to natural crevices it would not hold water. At the bottom of *b* and *c* were found fragments of ordinary ancient pottery. Connected with this crypt there seems to have been a passage through the eastern foundation wall of the portico leading to the tank already mentioned, which probably supplied water to the sea.

The lintel and jambs of this small doorway are of marble, the courses to the east of it which range with them are of poros stone. The top course has been partly broken away and exhibits a very peculiar construction forming a thin lining of poros stone which covers the marble which forms the outside wall, and is fixed to it by being *run* with lead. This appears to have been intended for the support of a pavement *flush* with that of the western apartment. See Fig. 17.

From the middle parts of the western cross wall two walls, shown by dotted lines on the plan, run eastwards. These walls are not Hellenic, but were part of the construction of the church which subsequently occupied the site.

¹ I was indebted to Dr. Dörpfeld for this view of the matter, but I had already noted down some of the suspicious circumstances which are explained by this hypothesis.

At a distance of 35.16 feet from the west wall we find another cross wall of the same thickness, which may be called the middle wall.

On the inner face of the south wall of the cella, Plate XLIV., we have evidence of two floor levels; the lower with its pavement flush with that of the western apartment, and the other eastwards of the middle wall about .82 above the pavement of the eastern portico. Here the lower part of the wall is composed of poros stone, and very rough, and could never have been intended to be seen. On the opposite or north side there are indications of a pavement level with that of the western apartment as far as about 6 feet beyond the middle wall. Then the surface assumes a different character: the jointed stones which gave evidence of the pavement are no longer found, and the surface above their level becomes less finished, but this rougher

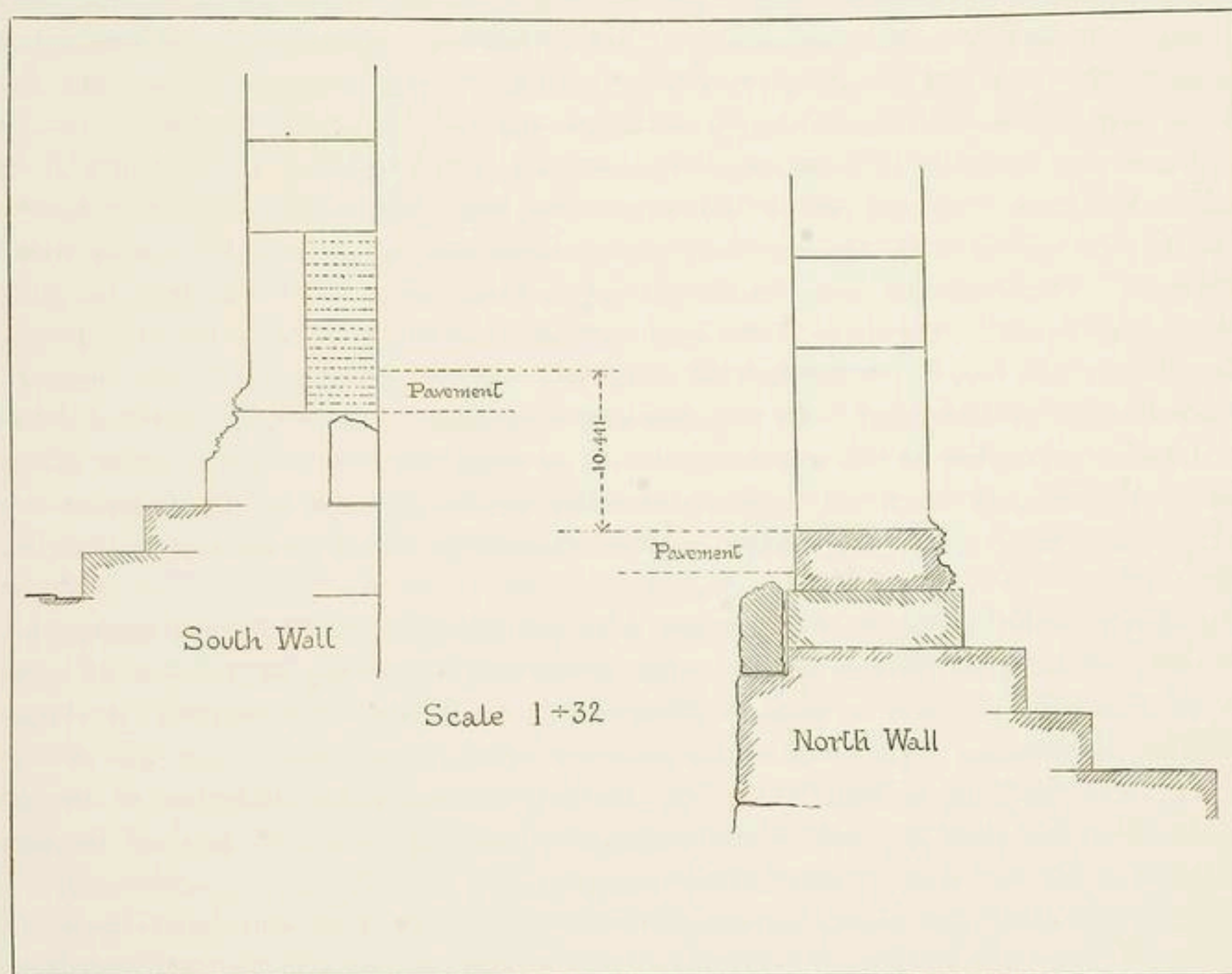


FIG. 17.

character takes a sloping line, as if following a flight of steps ascending to the higher level of the eastern apartment. This will be seen by reference to Plate XLIII., where the indication of the sloping line may be seen in the margins of the orthostatae, and the course above it, and also in the knobs left on some of the blocks. The pavements appear to have been torn out with great violence, as shown by the ragged edge exhibited by the courses which supported them on both sides of the temple (see Plates XLIII. and XLIV., and woodcut Fig. 17).

As respects certain loopholes in the cella walls which were first noticed by Herr C. Bötticher,¹ and have led to a good deal of discussion. I carefully examined them, and am convinced that they have no claim to antiquity whatever.

The middle wall has been entirely destroyed, and where it intersected the cella walls has been cut off close to the surface. The courses of the orthostatae, however, are of smooth work, and were not bonded into it. The appearance of the masonry where it joined the north cella wall is that of an anta or pilaster of which the projection was worked out of the solid blocks of the cella wall stones, but at the southern extremity it (the middle wall) was bonded into the cella wall in the usual way. This wall was probably cut away when the temple became a church.

The communication between the two levels of the double temple—*διπλοῦν οἶκον*—was effected

¹ *Untersuchungen*, p. 198.

internally by the staircase already described, and externally (see Plate XLV.) by a flight of steps at the north-east angle of the temple of which the width was probably that of the projection of the north portico. The insertion of some of the steps can still be traced in the basement wall which carries the flank of the eastern portico. Between these steps and the north portico was a pavement, the slabs of which no doubt covered the tank mentioned in connection with the crypt.

Within the portico, and immediately over the Neptunian marks, the pavement has been broken away, but the joints of the parts which remain suggest that there may have been a narrow oblong opening, covered perhaps with a metal grating or shutter, which admitted of being opened to show the sacred relics.

Some alterations and reconstructions when the temple was converted into a church have been referred to. There is very strong probability that at this period the upper part of the western wall was taken down and rebuilt. The composition referred to with engaged half columns outside and narrow pilasters within, having windows between them, was blown down in a storm in October 1852.¹ My attention was called by Dr. Dörpfeld to the fallen fragments, as well as to the manner in which they had been fixed to the undoubtedly genuine work they rested on, which includes the string and the bases of the half columns, but not the bases now visible of the narrow internal pilasters.² No doubt whatever could remain after the inspection of these details—viz. the half columns, their flutings, and particularly their capitals, the mouldings of the windows, and the bases of the internal pilasters—that the workmanship was of a very inferior character, in no degree better than that of the late adaptations in the Naos of the Parthenon, already described, when it was converted into a church; and this work is probably of the same period, viz. about the fourth century A.D., and before the classical tradition had given way to Byzantine feeling, so that the general design of the front was harmonized to that of the temple, whilst to meet the new demand for light, windows of the ordinary domestic type were supplied in the place of the solid wall which had originally stood between the attached columns, the *κειμένον κίωνων* of the well-known inscription which gives the report of the commissioners appointed in the twenty-second year of the Peloponnesian war,³ B.C. 409. The inscription mentions no windows; the attached columns which are mentioned are clearly those of which the bases remained, which are of the original workmanship.⁴

As respects the tooling, the cramps, and other particulars of the execution of the fallen fragments referred to, they are identical with what is exhibited in those other parts of the interior which belong to the adaptations required for the church.

Amongst the fallen masses is a stone which appears to have been the central block of the tympanum of the north portico. The height from the apex to the bed is 3.572 feet, and the angle derived from it for the pitch of the roof is 14° 5' 6".

The vignette at the head of the chapter is from a photograph kindly taken for me by Dr. Dörpfeld of a fragment preserved on the Acropolis. I was unable to learn where the fragment was found, but there cannot be a doubt but that it is part of the cymatium of the north portico of the Erechtheum. It had evidently been used as a building stone, and a portion of the bottom bed has been *trimmed off*. The quantity which it has thus lost is probably merely a beading resembling that at the bottom bed of the cornice, and there can be little error in restoring it as shown in section on the woodcut, Fig. 18. The quality of the carving is unsurpassed by that of any of the details of the temple. A fragment having the same profile and resembling it in the general ornamental design, but of much inferior workmanship, has also been found, and seems to point out that there had been some reparation of the roof of the north portico at a much later date than its erection. Two other marble fragments, of which the section is shown in Fig. 19, found recently on the north side of the temple, appear

¹ The same storm that threw down a column of the Olympieum.

² Stuart seems to have found a section of better character than those which now remain.

³ We can hardly suppose that the western wall was never built till after the decline of the arts. It is true that the commissioners seem to have found a good deal unfinished in this part of the temple, but it is almost impossible to imagine that the western front could have remained in so unfinished a condition for upwards of 600 years as to await its completion

until the old technical skill had entirely been lost; it is more probable that some fire or accident had so much ruined the original front that it required to be entirely rebuilt in the fourth or fifth century A.D.

⁴ τὸν κίωνων τῶν ἐπὶ τοῦ τοίχου
τοῦ πρὸς τοῦ παρθενείου·
III κειμένων κίωνων
ἄτρητα ἐκ τοῦ ἐντὸς ἀεθλη-
μίων ἰκάρτων τοῦ κίονος τρία
ἡμιπόδια.

also to bear witness to some repairs of the cornice of the main building. In size, shape, material, and place of discovery they agree well with the position here assigned to them; but they can only be supposed to represent the original cymatium in block, for the execution is not that of the best period, and in the original the lower part, shown here as a plain fillet, would doubtless have been moulded and the face of the cymatium itself enriched with carving. The great difference between the size of this moulding and that of the cymatium of the north portico may be thus accounted for, viz.—As the other members of the two cornices have practically the same height, differing only in projection, a taller cymatium would be required to give the entablature of the north portico its due importance.

Plate XLV. is intended to show what I consider to have been the main features of this intricate Temple in its original state, my views on this subject being based very materially on those of the late Mr. James Fergusson.¹

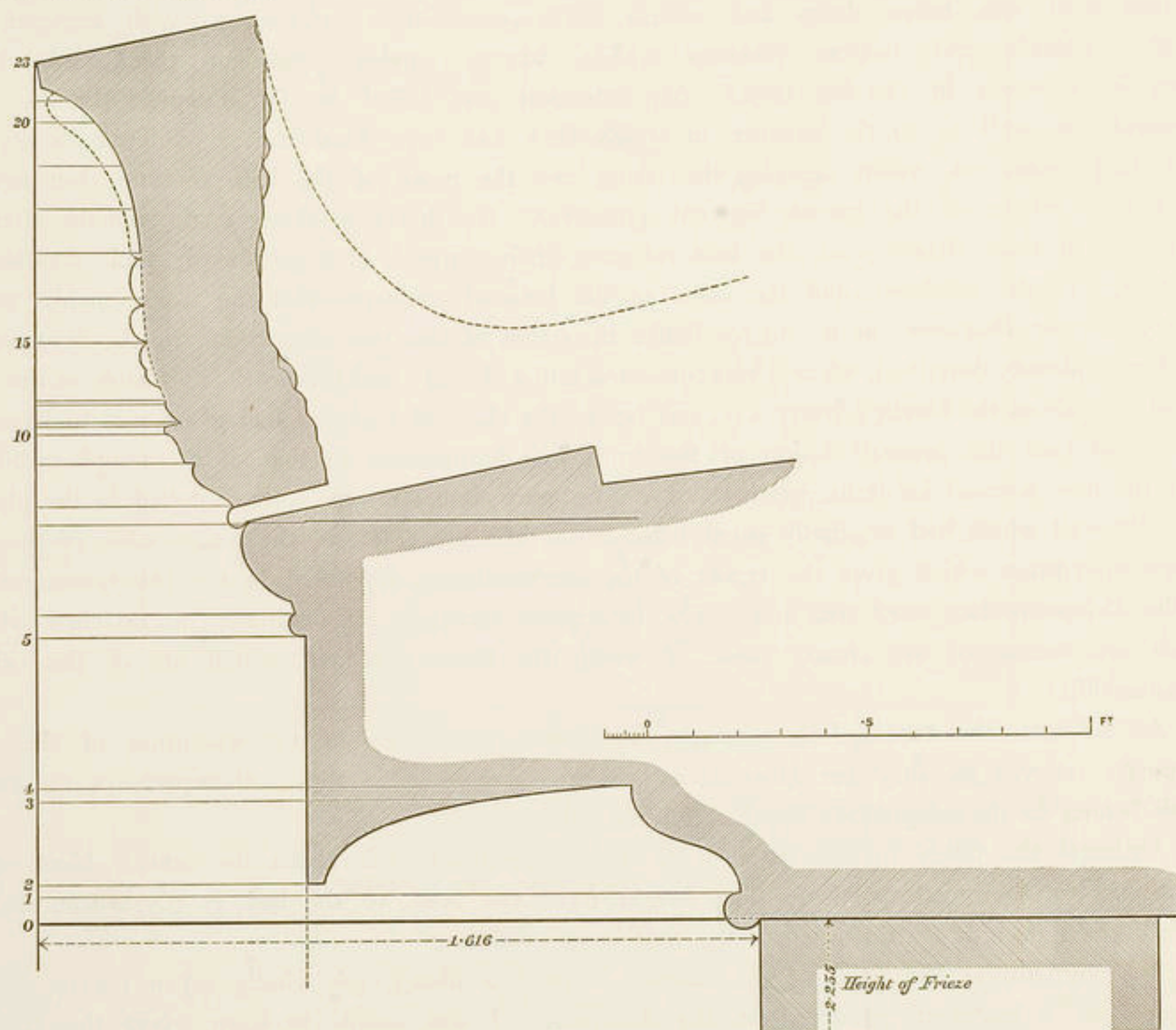


FIG. 18.

TABLE OF ORDINATES.

No.	VERTICAL.	HORIZONTAL.	No.	VERTICAL.	HORIZONTAL.
23	1.937	0	11	1.118	.275
	1.880	.018	10	1.101	.280
	1.850	.090		1.025	{ .325
20	1.80	.143			{ .350
	1.70	.200		.945	.432
	1.60	.228		.910	.470
	1.50	.241		.703	.578
	1.40	.238	5	.660	.592
15	1.30	.245	4	.298	1.333
	1.180	.290	3	.270	1.0
	1.167	.278			{ .628
12	1.132	.325	2	.087	{ .592
12	1.132	.325	1	.062	.572

¹ *Sessional Papers of the Royal Institute of British Architects*, 1876.

According to this restoration it will be seen that the great door of the north portico opened into a lower chamber, whilst the access to the Temple of Minerva Polias was from the east. It may seem a difficulty to explain why the most magnificent portico should lead to a subordinate shrine, but the eastern portico with its six columns, although of smaller diameter, was scarcely if at all of less importance, and the doorway could not have been much inferior in width and height. It would have been essential that the statue of the goddess should occupy the position of greatest

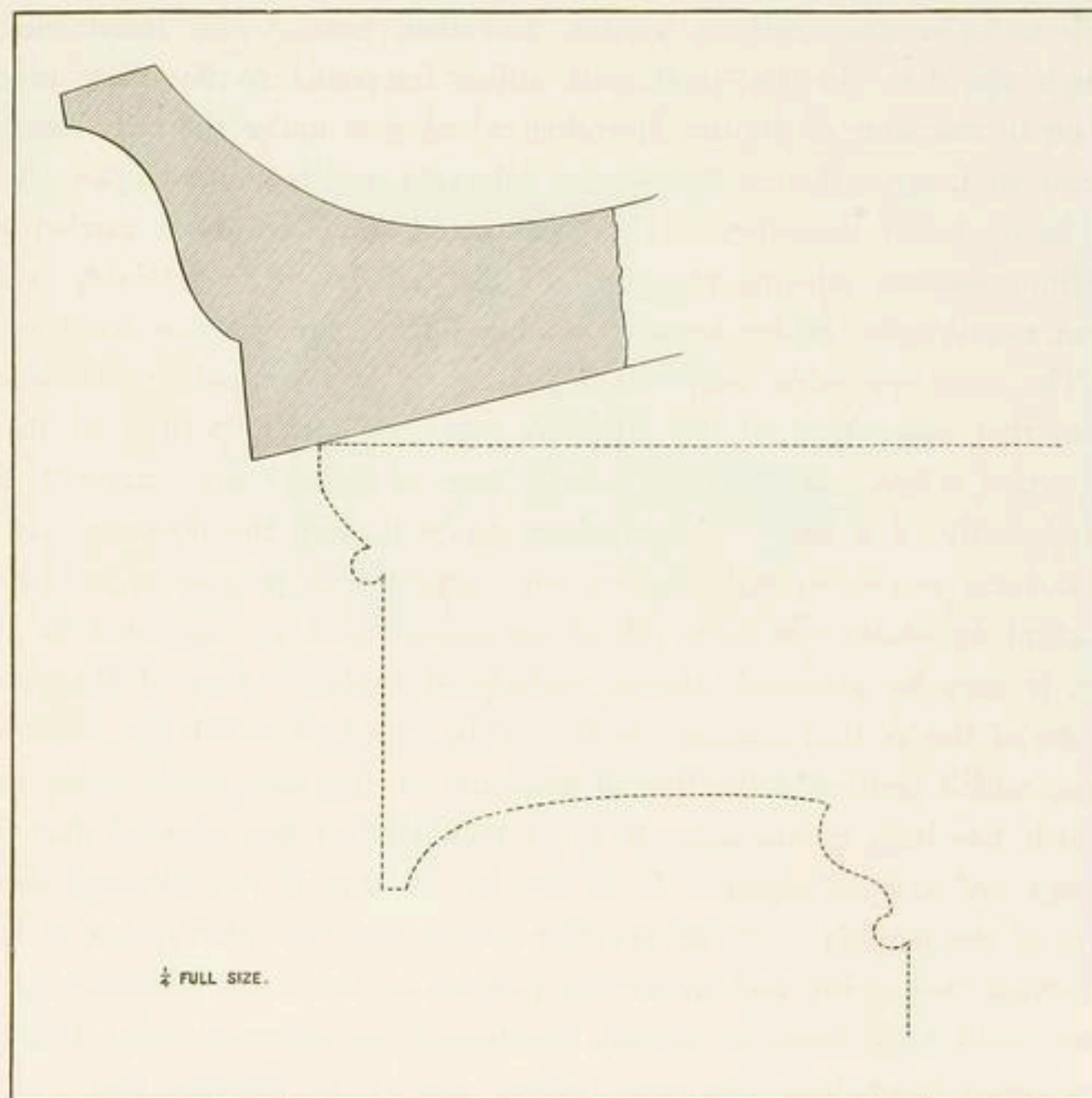


FIG. 19.

dignity—namely opposite the eastern entrance—and the light from the door would have been quite sufficient for it, especially as this statue, although the most revered in Athens, could not as a work of art require to be very carefully scrutinized. The difference of level also obviously gives pre-eminence to the eastern site. Between the east entrance and the middle wall we may place the subordinate objects mentioned by Pausanias—the shrine of Erechtheus of Butes and Vulcan, etc.¹

The width of the aisles shown on this restored plan is derived from the doorways which lately existed at the western wall already described. But their exact original position must be considered indeterminate, because the whole interior of the temple, including the western cross wall as already remarked, appears to have been much altered.

Whatever uncertainty, however, arises from these changes, the longitudinal walls which supported the internal columns probably had some relation to the position of the engaged columns of the west front, and therefore the position shown on the plan may be assumed to be approximately true.

In the lower chamber of the temple a statue very probably, as Mr. Fergusson suggests,² was placed in the niche opposite the great door. The floor of the lower level, as is proved by the orthostatae and other evidences of pavements at the base of the walls, must have extended along each of the aisles as far as the middle wall on the south side, and to the steps which have been described on the north, but in the middle a space of about 22 feet by 20 would be occupied by the supports of the upper temple. Inside this block was perhaps a treasury, and through this chamber, whatever it was, no doubt there could have been a communication by steps and a low passage with the doorway leading to the crypt.

¹ Leake's *Topography of Athens*, etc., 2d ed. p. 578.

² *Sessional Papers of the Royal Institute of British Architects*, 1876.

From the western apartment, as already described, the door in the external wall leads out into a court by steps of which the traces are shown on Plate XLII. We may consider this court as forming part of the Pandroseum, and in it, following the very probable suggestion of Mr. Fergusson, we place the olive tree and the altar of Jupiter Herceius, and westwards of this court, but shut off from it by a door, is placed the dwelling of the two maidens, or Arrephori, with their Sphærestra or playground. The arrangement of the temple above described accords with the anecdote preserved by Philochorus.¹ The dog may be supposed to have entered by the principal door in the eastern portico, or equally well by the northern portico, and then having *run down* the steps into the Pandroseum through the door in the west wall, which happened to be open, proceeded into the court, and leaped on to the altar of Jupiter Herceius, which was under the olive tree.

The thin screen wall, strengthened by piers at intervals, which abutted upon the podium of the south portico has been already described. This wall could not have been carried higher than the cornice of the podium without injuring the effect of the statues. The retaining wall referred to is very rough, and an examination of its foundation shows that it never was lined or faced with any other masonry. The most probable supposition is that it was concealed with plants or creepers. It would seem also that some kind of low structure lay against that portion of the west wall, and of the Caryatid portico, where, as described above, the mouldings are uncarved or unfluted, and where the trace apparently of a beam lying against the wall over the doorway has been described. These incomplete features would be explained by supposing that a pergola or trelliswork roof suited to vines or other climbing plants had been placed against the wall, as suggested in Plate XLV.; the construction being, it may be assumed, almost entirely of timber. One of the peculiarities of the western wall consists of the vertical channel, as it may be called, of which the shallow projections are figured on the plan, which continues the line of the anta of the south-west angle on to the face of the great stone which has been mentioned. It is on each side of this channel that the mouldings of the horizontal strings are stopped square. It is easy to see that if this channel formed the back of one of the supports of the pergola, both its peculiar section and the interruption of the strings would be accounted for. Near this point, and under the podium of the south portico, a recess is shown in Plate XLV. There could have been, as already mentioned, no communication here with the portico itself, but the great stone must have had some object, and if we suppose that a recess or cave was here formed, would it not have supplied a fit den for the sacred serpent, where it could have had access to the external air, whereas, in the confined enclosure of the temple itself, the effluvia might not have been free from serious objection? The neighbouring tank also might have been used in combination, especially for a water-snake. Here also we may look for an access to the tank, which would have been a necessary provision.

The latest excavations, by which the surface of the rock westwards of the Erechtheum has been entirely cleared over a considerable area, have yielded evidence fully confirmatory of the views above stated. The plate has been adapted to the new discoveries. The foundations of the oblique boundary wall to the north have been traced to a distance of about 150 feet from the temple, and at about a quarter of that distance, and by the side of the wall and within the court, is a levelled area about 8 feet square, well adapted for the foundation of the altar of Jupiter Herceius; and close to it, towards the west, is a large and deep natural fissure in the rock where the roots of the olive tree would have found nourishment. In the angle between the west wall of the temple and the rough sub-basement the rock has been levelled for the foundation of some slight superstructure (see Plate XLI.) The shape seems to conform to the proposed plan of the pergola.²

Speaking of the temple generally, it is impossible not to notice the absence of rigid balance in the different parts both as respects the plan and the elevation, nevertheless its exquisite beauty and harmony is indisputable. It should be observed, however, that in each particular part the symmetry is perfect; for instance, not only are the columniations spaced with the greatest exactness, but the joints of the stones forming the drums run exactly level.³ The peculiar combinations,

¹ Leake's *Topography*, p. 339.

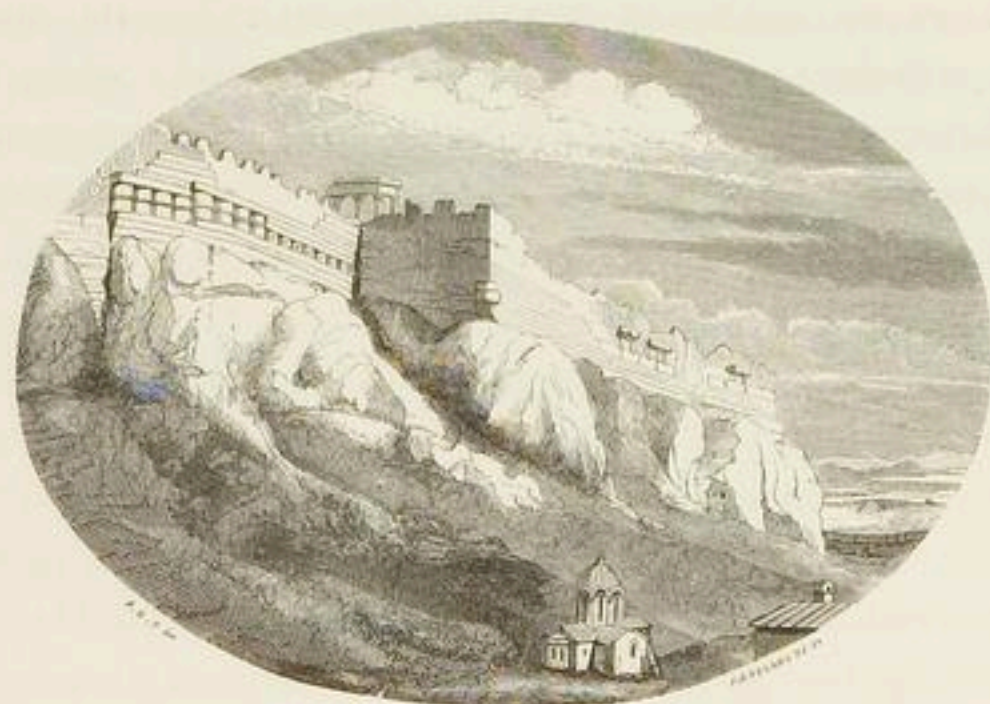
² The general appearance of this foundation is that given on the Plate, but it should be mentioned that the trace of the square pier is less clearly

artificial than the parts shown in connection with it.

³ This exactness of the joints shows that the marble was not concealed in any degree by painting.

therefore, which we find, are not haphazard, but are due to deliberate intention, part of which, however, may have had reference to some antecedent requirements which had their origin in a previous temple. Considering the numerous vicissitudes and the ill-treatment to which this temple has been subjected, it is very fortunate that we still retain so many precious relics of its original architecture.





CHAPTER XIV

ON THE REMAINS OF AN EARLIER TEMPLE ON THE SITE OF THE PARTHENON

MISCELLANEOUS FRAGMENTS BUILT INTO THE NORTH WALL OR PELASGICUM
OF THE ACROPOLIS. PLATE XLVI.

THE vignette at the head of this chapter shows these remains, which are also briefly mentioned in Chap. I. pages 1 and 6. The drums of columns of Pentelic marble there spoken of occur in those parts which are shown in the sketch to the reader's left, and also the salient angle which occupies the centre of the vignette. The entablatures composed of Piræic stone (with the exception of the metopes, which appear to be of Parian), occur in two groups on the right. These are drawn to scale in Figs. 1 and 2, Plate XLVI.

In the length of the architraves and breadth of the triglyphs and mutules these two groups differ considerably, while the measurements of the metopes are nearly the same, and the height is identical in both. This latter circumstance, and the similar character of the details, clearly point out that they belonged to one and the same building. The upper surface of the stones forming the cornice to the broader or westernmost group is parallel to the horizon, in the others it is inclined, showing that the former were placed on the fronts and the latter on the flanks of the building to which they belonged. Some remains of colour have been preserved on one of the stones of the smaller group which has fallen, and was found imbedded in the talus at the foot of the cliff. The drums of columns twenty-six in number, are of marble, and are formed somewhat roughly into cylinders. The majority are finished and fluted for a small height at the base, thirteen are 6.233 and five 5.601 in diameter. The method of forming the contour of the flutes, which are accurately worked, is given in the plate (see Fig. 3, Nos. 1 and 2), close to which the cusp of one of the larger flutes is compared with one from the peristyle of the existing Parthenon, placed concentrically without it. Contiguous to the two drums in the salient angle of the wall, in that part which in the vignette is in shade, are several fragments of marble which seem to have formed a stylobate. In these the height, 1.8 foot, does not differ appreciably from that of the upper step of the Parthenon. The correspondence in these dimensions, and between the two diameters just mentioned, with those of the existing peristyles and inner order of the Posticum respectively, is very remarkable, and makes it necessary to measure them very carefully, in order to feel satisfied that they really belonged to a different work, and are not merely rejected frusta of the Periclean temple; like those already mentioned in Chap. I., which were found in an excavation eastwards of the Parthenon.

The principal direct proof by which I have satisfied myself that the drums in the north wall of the Acropolis could never have been intended for the Parthenon, is drawn from the form of the flutes as determined by the Cymagraph. The reader may readily compare those of which we are now speaking with the flutes of the Parthenon given in Plate XXI. The arris of the one and the fillet of the other also show a decidedly characteristic difference; and we may presume from the analogy of the Theseum that the former is the older type; nor is the real though slight difference of diameter to be neglected; and all this is independent of the argument drawn from the words of Thucydides (I. 93), that these frusta of columns, as well as many other old materials, were built into the wall at the time of the celebrated embassy of Themistocles to Sparta¹ (about 477 B.C.); and if they cannot be ascribed to the Parthenon, neither can they have formed part of the same building as the entablatures above described, for in addition to these and to the marble drums, recent excavations have brought to light at least six large poros stone capitals, as mentioned in Chapter I. page 6, and some large drums of the same material, one of which, particularly well preserved and coated with the usual film of fine stucco and carefully fluted, has the diameter of 5.811. The upper diameter derived from the capitals present three varieties of measurement. From one of these, which starts from an upper diameter of 4.282, we obtain a very close approximation to the breadth of the abacus—7.150. Another is very distinct as to the diameter—4.096—but fails to give the abacus; and from the third set both features can be accurately recovered, viz., 3.727 and 7.030 respectively. On some of the capitals which have this measurement, as well as some drums that can be associated with them in size, there are distinct marks of the action of fire. The depth of the first-mentioned capital is 3.58 that of the third, 3.43. The curvature of the Echinus is similar in each case, and has a considerable resemblance to the example at Ægina. If from the analogy of the latter temple we calculate the lower diameter of the column, we should obtain 5.89—5.64 and 5.14.² The former, as already remarked p. 6, should be placed on the front, the second on the flanks of the temple to which they belonged, whilst the last would be exactly suitable to the Pronaos or Posticum—all of them being in due keeping with the poros stone entablatures.

With this evidence it is of course impossible to associate the marble drums with the entablatures, and we must suppose that they were prepared previous to the Persian siege, with the intention of rebuilding the temple more magnificently, and that afterwards they were used as materials which came ready to hand in building up the wall with stones taken from the ruined temples both above and below them.³ From the quality of the material and workmanship we can hardly be wrong in attributing the preparation of these marble drums to the age of the Pisistratidæ.

As respects the form and dimensions of the older Parthenon, the data for its restoration are partly drawn from the fragments described above, and partly from such further evidence as the sub-basement of the temple still affords, together with the record preserved by Hesychius, *Ἐκατόμπεδος νεὸς ἐν τῇ Ἀκροπόλει Παρθενῶν κατασκευάσθεις ὑπὸ Ἀθηναίων μείζον τοῦ ἐμπρήσθεντος ὑπὸ τῶν Πέρσων πόσι πεντήκοντα*. Between the finished angles the width of the sub-basement on the west front was 104.253. The length, judging from the character of the masonry near the east end and measured from the south-west angle, appears to have been 231.48 (see Plate IX. and p. 18).

These dimensions bear to each other the ratio of 9 to 20. The width also equals the length of the Theseum on the upper step. Along the line of one of the courses of the south flank—namely, 7.1 feet below the great marble steps—occur the chiselled marks mentioned in Chap. I. Section III. Three of these marks are shown on Plate IX. Each mark is a sharp V-shaped cut, which has been coloured red and formed in a separate smooth tablet about .2 square. The first, reckoning from east to west, is 20.56 feet westwards of the point where the panelled blocks change their character (see Plate IX.), and where presumably the extension provided for the present Parthenon joins the older work.

¹ The words of Thucydides, "πολλὰ τε στήλαι ἀπὸ σιμῶν καὶ λίθοι ἐργασμένοι ἐγκατελέγησαν," would be alone conclusive, if we were sure that he is speaking of the walls of the Acropolis, see Leake, p. 312.

In 1885 I ascertained that some of the masonry which rests upon the marble drums in question is exactly of the same character as the stones forming the cornice, and have similar sinkings for the use of the lifting shears to those shown on the plate, and this proves that these drums were inserted in the wall simultaneously with fragments from the demolished temples.

² If the columns had had the *entyle* arrangement their diameters on front and flank would have been 5.884 and 5.594 respectively.

³ The north wall, as mentioned in a note, p. 6, shows that the 2 or 3 lower courses—those, namely, in which both the marble and poros stone drums and the large capitals are found—were built in an extremely hurried manner. Above these the work is very carefully done. It is in the latter part that the entablatures have been introduced.

In the measurements which follow I call this starting point Y and the chiselled marks A B C, etc., in order as far as T, the last of the marks; and I call the south-west angle of the temple X.

Y to A	20.560	G to H	6.894	O to P	6.226
A B	7.873	H I	7.185	P Q	6.184
B C	6.874	I J	7.912	Q R	11.722
C D	7.028	J K	6.547	R S	17.272
D E	8.026	K L	4.810	S T	12.827
E F	8.910	L M	5.977	T X	57.775 ²
F G	6.992	M O	14.040 ¹		

It has been shown that the architraves which give near approximations to the columniations on the front and flank measure respectively 13.268 and 12.561, the former measure having been derived from three and the latter from four stones. We can find very remarkable coincidences between multiples of both these quantities and certain combinations of the distances between the marks given above—combinations, it should be observed, in every case of continuous measurements, and not arbitrarily selected.

Front measurements.	Multiples of 13.268.	Flank Measurements.	Multiples of 12.561.
H L 26.454	26.536 = 2	Y E 50.361	50.244 = 4
M G 26.450		B G 37.830	37.683 = 3
L P 26.243		C H 37.850	
Y G 66.263	66.340 = 5	D I 38.007	
B K 66.368		E J 37.893	87.927 = 7
K S 66.231		J P 37.600	
Y X 231.633	231.665 = 17½	H S 87.875	
or 231.481		R X 87.874	12.561 = 1
to finished arris		O Q 12.410	
		S T 12.827	
		Mean of the two latter 12.618	

It is utterly impossible to ascribe so great a number of coincidences to chance; and we may now proceed without hesitation to correct our approximate columniations by the small amount of +0.30 in the case of the fronts and -0.26 in the case of the flanks, which thus become 13.238 and 12.587 respectively; and we may notice that these quantities bear the proportion to one another of 20 to 19 (13.238 : 12.576).

These marks evidently served a similar end in the building on which they are found with those used by modern masons for the purpose of setting out their work full size on an extended floor or boarded space. These, therefore, in any attempted restoration of the earlier Parthenon cannot fail to be of the greatest use. In Appendix II. p. 116, I propose briefly to enter upon that question, but here I only desire to prove that the combinations I have pointed out serve to establish beyond the possibility of a doubt the relationship between the entablatures and the other fragments associated with them and the earlier Parthenon, and as Mr. Lloyd has shown in Article 1 of Appendix I. several instances of the important part played by the columniation of a temple in fixing other proportions, it is therefore only natural that it should show itself as a common measure in the combinations of the dimensions of the various more important details which there is no doubt are implicitly contained between these marks, and it should be mentioned that they have little or nothing in common with the present Parthenon. The reader is referred to Art. 2 in the Appendix for the grounds upon which the plan given in the woodcut 20 is founded. Upon it are shown the places occupied by the marks on the sub-basement wall as well as their suggested positions on the plan. The tinted portion is that part of the sub-basement area which lay outside the temple.

¹ It is possible that a mark may have been lost between M and O, where the stone has been defaced for a small space. If so, we should have approximately M N = 5.78 and N O = 8.26, with a margin of about .1 either way; but no conclusion can be gathered from the appearance of the wall.

² The dimension would be 57.623 to the finished arris of the panelled blocks.

The general conclusion arrived at is that the temple, as Colonel Leake supposed, was hexastyle, and that it had sixteen columns on the flank (a number paralleled in the *Heraeum* of Olympia and approached at Corinth with fifteen), that the stylobate had three steps, and that there was the proportion of 8:3 for the length and breadth on the middle step. The dimensions on the upper step being 193.125, and 69.822. The length of the cella appears to have been 145.09, which is fifty feet shorter than that of the present Parthenon, which measures 196.39 in accordance with the record above quoted.

The width, as stated above, is practically identical with that of the *Cecropium* mentioned in pp. 5-6. It seems unreasonable to suppose that two temples having exactly the same width could have existed side by side, and it is a more probable explanation that the ancient temple had been taken down in order that a new temple might be built on a larger scale, and on the highest part of the rock. This then was the temple destroyed by the Persians to which the marks of fire upon

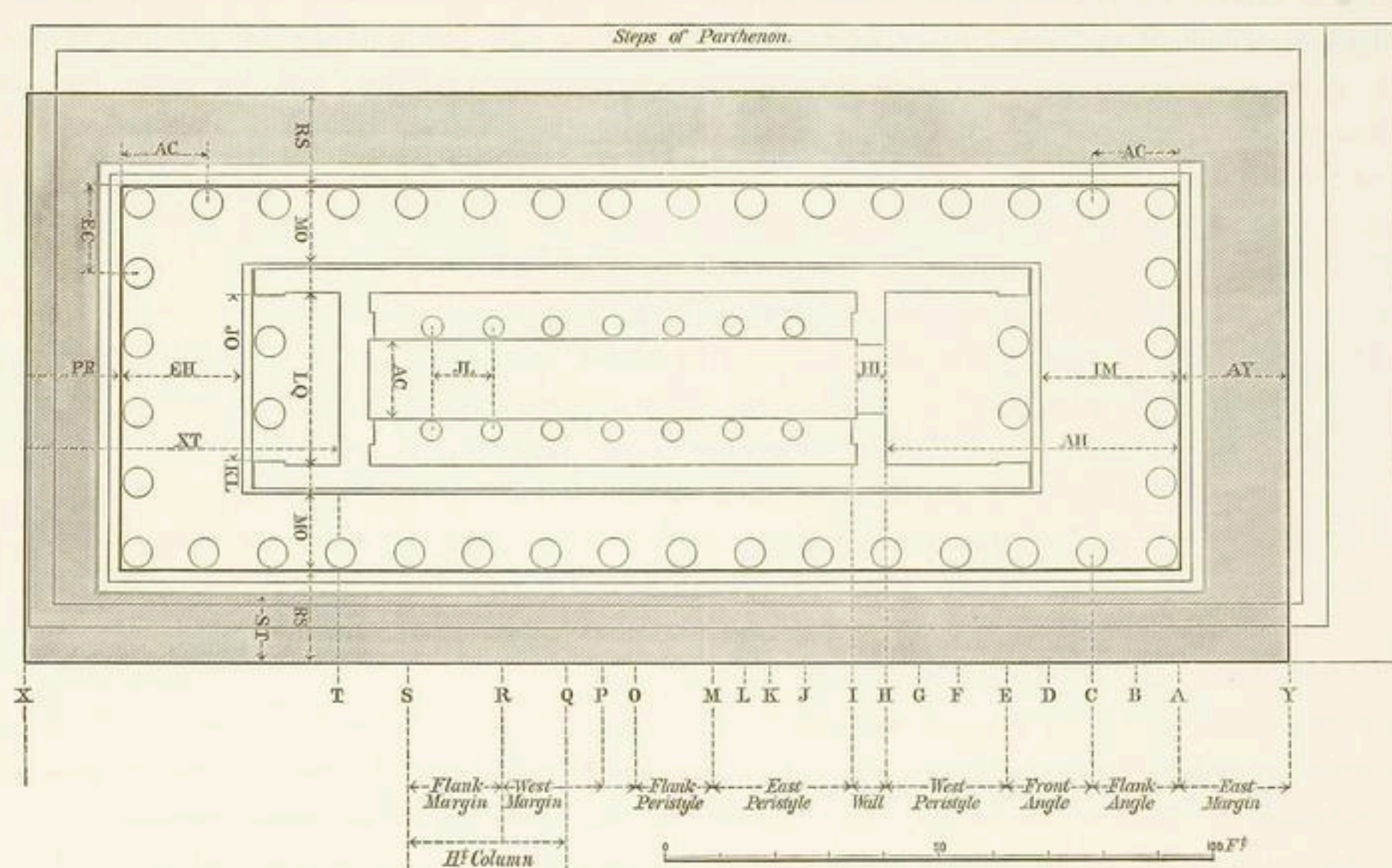


FIG. 20.

the remains of the columns of the Pronaos and Posticum bear witness. The columns of the Peristyle on which this evidence is not so distinct would naturally have been less exposed to it.

The justification of this restoration arises partly from the extraordinary exactness with which the measurements derived from the marks produce the sum total of the length both of the front and the flank, and from the exact proportions which are shown to result from their use, and partly from the agreement with the words of Hesychius with respect to the length of the older and the newer temple, but also and very particularly from the natural order and sequence in the employment of the marked distances. The point A, for instance, coincides with the eastern angle of the upper step, and adjoining this point we find in AC and CE the columniations adjacent to the angles, which are elements of the very first importance in spacing the colonnades. Then follow the peristylar spaces, interrupted only by the Pronaos wall in its proper place. The wall of the Posticum being also determined by the mark T; and it will be observed by inspection of the woodcut that the above mentioned form only a part of the continuous order of measures by which the main elements of the plan are marked off.

Assuming then that the temple was hexastyle, we may presume that the reason which led the builders of this temple to extend so greatly its length with respect to the breadth was to produce an imposing effect from a distance, as is remarkably the case in the existing Parthenon, by making its length harmonize with the extended ridge of the Acropolis rock.

A portion of the Cimonium contains some fragments, represented in Fig. 4 in the plate, which from their identity of height (4.4) with the frieze found in the Pelasgicum, seem to have belonged to the same structure. It is possible that these fragments formed the top of the cella wall on the flanks of the temple; but with respect to the returns of this cella wall on the fronts, *i.e.* the porticoes of the Pronaos and Posticum, it is not unlikely that there was an internal frieze decorated with sculpture, as in the Temple of Theseus. Mr. W. Watkiss Lloyd has expressed an opinion that a bas-relief of archaic style found on the Acropolis, and usually called "Venus mounting her chariot" (a cast of which may be seen in the Elgin Room in the British Museum), is to be assigned to the original Parthenon. The joints of this slab indicate that it formed part of a continuous subject, and its height, about 4 feet, goes far to justify the conjecture that it may have been a portion of an internal frieze, similar to the Panathenaic procession in the existing Parthenon.

The three fascia moulding which is shown on the right hand part of the Plate (XLVI.) and near the bottom, is clearly identical with that which still remains on the sub-basement wall (see Plate IX.) In the first temple it probably formed a cornice or finish to the wall, but in incorporating it into the new work so as to support the outer step its position was somewhat shifted, and its upper member reduced from .97 to about .6. Under a broken portion of the stylobate near the south-west angle one of these stones may be seen employed as old material for the foundation of the inner steps.

CHAPTER XV

ON THE THEORY OF THE OPTICAL CORRECTIONS ADOPTED BY THE GREEK ARCHITECTS

I HAVE reserved for this concluding chapter the few remarks I have to make on the reasons which seem to have influenced the Greek architects in their adoption of the delicate deviations from ordinary perpendicular and level construction which have been described. It is difficult to imagine any other reason for these deviations than that they were intended as optical corrections (or as corrections of certain influences, about to be considered, which tend to make the apparent differ from the real form), and we shall I think be enabled to trace advantages gained in this respect sufficient to have recommended them to artists who were ever seeking to elaborate to the highest point of perfection the works on which they were engaged. I shall content myself with suggesting an explanation in each particular case, without attempting anything so difficult and probably so vain as to search for a theory embracing all cases.¹ It seems to me, indeed, that the notion of there being any such theory is liable to serious objections.

The form of the eye is the reason commonly assumed for applying the considerations of spherical perspective to objects presented to it. This however takes a point for granted which is not universally admitted, namely that the phenomenon of sight results immediately from the spherical image formed on the retina. Granting however this to be established, yet inasmuch as our judgment of the forms of objects is entirely a matter of education and experience, complete allowance is made for the particular shape of the image formed within the eye, in the same way in which an astronomer sufficiently acquainted with his instrument is enabled to make allowance for everything peculiar to it, and correctly deduces the places of the heavenly bodies from readings which would be of little value if adopted without correction.

Thus a perfectly even straight line on a uniform background, if presented by itself to the eye, will appear absolutely straight whatever be the image formed on the retina within the eye. But the judgment is very liable to be influenced by other causes inherent in the object, and external to the eye itself; such as inequalities of strength or colour either in the object or the background, and still more by other lines and objects seen in juxta-position. And there may be other causes of the same kind, which ought all to be well weighed before we venture to make so gratuitous an assumption as that the eye is physically incapable of judging correctly of the forms presented to it.

I do not go so far as to affirm that no general theory could be found which should embrace all the optical corrections of Greek architecture; but it seems more probable that the want of each correction was felt, and the correction applied separately. And this will appear the more likely

¹ An attempt has been made to reduce all the peculiarities of the Parthenon and similar buildings to a theory, by which every part was calculated so as to produce a particular effect from an arbitrary point of view. Partly on a similar hypothesis, Mr. Garbett derives the form of the entasis of the Doric column from considerations of spherical perspective. (*Rudimentary Treatise on the Principles of Design, etc.*, by E. L. Garbett,

Archit., London, Weale, 1850.) While unable to agree with the author on this and one or two other points, I have much pleasure in referring the reader to his work, with the greater part of which I so entirely agree that I find it the less necessary to enlarge here on many parts of the subject of this chapter.

when we consider the very long period during which the Greeks were working out the perfection of the Theseum and Parthenon; so that an amount of intellect, unparalleled in the history of art, was concentrated on a comparatively limited field, and time was given carefully to examine and obviate all the causes which tended in practice to distort the lines of the architecture. In fact we even see the steps of the progress. Neither does it seem consistent with the high esteem in which the architect was held by the ancients to suppose that he was merely employed to superintend the erection of temples according to a prescribed law. On the contrary, the slight but still evident changes of design which have been pointed out as introduced during the progress of the Parthenon, together with the varieties of feeling observable in the contemporaneous works of the Parthenon and Propylæa, tend to show (if indeed any proof were necessary) that the architects who embodied in their works the most advanced science of their day were not governed by fixed formulæ which they could not modify.

It is unnecessary to seek any recondite arguments for the propriety of using definite proportions in adjusting the plan and elevation of a building. Vitruvius draws the origin of proportions in architecture from the analogy of those of the human body; and the natural sciences point out to us so many instances of the use of definite proportions in the works of the Creator as fully to justify the hypothesis that they conduce to perfection and beauty in the imitative creations of art. Indeed this is universally acknowledged in the case of music. Form however seems to admit of a still more extensive range of harmonies. In the Parthenon most of the principal dimensions are aliquot parts of one another, the common measures being generally low numbers.¹ With respect to the smaller dimensions, it is probable that the approximate sizes of the details were chosen, some to please the eye of the designer and others for constructive convenience.

There can be little doubt that the origin of the horizontal curve was to obviate a disagreeable effect produced by the contrast of the horizontal with the inclined lines of a flat pediment, such as the *aetos* of a Greek temple, causing the former (*i.e.* the cornice) to appear deflected from the angles. As the line so affected is continuous, this deflection appears to take place in a curved line, and within ordinary limits it becomes the more apparent the more acute the angle which the contrasting lines make with each other.²

The diagram below, namely Fig. 21, will serve to illustrate the effect of deflection, which may be produced by contrasting lines. The columns represented are drawn with straight sides, and the appearance of entasis in the one and of attenuation in the other is given by the contrasting curve lines which are drawn close to them.³



FIG. 21.

It would seem from the passage of Vitruvius quoted in Chap. III. p. 22, that he supposed that the curvature originated in the stylobate, and that the entablature was made to harmonise with it. But the fact of its being found in the fronts only of the Temple of Neptune at Pæstum, which is no doubt a very early example, is decisive as to its being derived from the pediment; for otherwise it would have been equally or more important on the flanks. Again, the fact of the curvature being only found in the entablature of the fronts of the Propylæa shows that its introduction into that part of the composition did not depend upon the steps, for the

latter were made level; owing doubtless to the ascending roadway, which by breaking their continuity would have destroyed any beauty resulting from the use of a curved line in the stylobate.⁴ It is confined to the fronts also at Corinth.

¹ See Appendix I. Art. 1.

² The angle of the Doric pediment is about 13°. According to a rule given in Appendix VI. Art. 19, by which I attempt to determine the apparent deflection in any pediment, the maximum effect takes place at about 6°.

³ The following is an extract from a paper read by me in March 1846 to the Institute of British Architects on the subject of the curved lines of the Parthenon. "It is a matter of constant experience that the presence of a curved line distorts any right line in its vicinity, as for instance the tangent to a circle always looks bent contrary to the curvature of the circle, and the same thing is no less true of the chord. A small segment of a large circle may be made to look straight, or even bent contrary to its real direction, by

the juxtaposition of a curve of greater curvature. The same thing obtains more or less in a pediment where the converging lines have ultimately exactly the same relative position as an arc and its chord, and any Greek portico to which these corrections are not applied will give something of this feeling if we look attentively at the angles."

⁴ The increments of curvature in the stylobates of the Theseum and Parthenon are greater than in the entablatures. This is most remarkable in the fronts of the two temples, where they have about the ratio of 4:3; in the flanks of the Theseum that of 9:10, and in those of the Parthenon of 7:8. This at first sight seems to be at variance with the above hypothesis of the derivation of the curvature. If in the Parthenon, however,

We may I think feel satisfied that the curvature given to the horizontal lines of the fronts of a temple is as important a condition of the perfection of the pediment as the entasis is to that of the column; and further, that the curvature of the lines on the flanks, although a subordinate, is yet a considerable improvement on the straight line.

In the very early example of the original Parthenon (see Chap. II. p. 20) we find a curvature applied to the flanks as well as to the fronts, that of the former being, as in all other instances, more delicate than that of the latter.

We may attribute the use of this additional adjustment to the feeling of a greater appearance of strength imparted by it, to the appreciation of the beauty inherent in a curved line, and to the experience of a want of harmony between the convex stylobates and architraves of the fronts and the straight lines used in the flanks of the earliest temples. And further, if we may suppose the first examples of its application on the flanks to have occurred on lofty situations like the Acropolis, the presence of a delicate but not inappreciable curve in what may be considered as Nature's great and only horizontal line, the sea-level, may possibly have combined with other causes to have suggested its use.

All that now remains to be noticed is the peculiarity in the pediments of the Theseum mentioned in Chap. XI. p. 68, viz. that besides the curve in the horizontal lines, the inclined lines are themselves very slightly convex.

Was this done from a fear lest the curve given to the cornice should by contrast make the inclined lines appear deflected? But as these inclined lines in the Parthenon are perfectly straight, we may presume that this correction was considered to be comparatively unimportant.

The deviations from the perpendicular in the vertical lines affect the construction and appearance of the Greek temple nearly or quite as much as the horizontal curvatures. They consist, first in the *diminution* of the columns; secondly in the *inclination inwards* of their axes, of the walls, and most of the other plane faces; and thirdly in the *inclination outwards* of the antæ, the faces of the abacus, acroteria, and coronæ.

1. The *diminution* of the upper, or as we may rather say the enlargement of the lower diameter of the columns, accords with the obvious mechanical principle that in any system of framework in which any member is required to resist a pressure acting at a distance from the point from which it derives its origin and support (the strain being the greatest at the origin), the chief strength also must be there provided. In the column this principle applies statically, the origin is the stylobate, and the neck is the point where the pressure of the entablature is transmitted to it through the capital. Accordingly, the shaft of the column is made to increase downwards, whereby the material is economised and the general efficiency increased. Illustrations of this rule, more especially in its dynamical bearing, are to be met with almost universally in the works of Nature, as in the limbs of animals and in the trunks and branches of trees.¹ The recognition, either through innate feeling or from practice of this principle, has become so much a part of our nature, that a pilaster built with parallel sides, as we not unfrequently find in Roman and revived classical works, generally appears broader at the top than at the bottom;² and further, if the diminution of a column be but slight, it is not usually noticed, except by an educated eye.

2. We may derive from this last consideration the necessity of the second adjustment, viz. the *inclination* of the axes of the columns. For since some portion at least of the effect of the diminution is neutralised and rendered, so to speak, latent, in overcoming the disposition to imagine an excess of breadth in the upper part of the shaft, the upper diameter of the column appears larger than it really is; whilst nothing prevents the upper intercolumniations which are greater than those below from producing their full effect. If then the axes of the columns are perpendicular,

the five middle columniations only are compared, the difference is very small, and of this some part of the excess in the stylobate is due to the fact that the central 14 feet of the architrave is a straight line; the chord of the curve; whereas in the stylobate the stones are smaller and the deduction from the full curvature is less. The chief excess in the stylobate over the architrave occurs at the extreme columniations, where a certain amount of extra slope may have been added for the sake of better drainage.

¹ In many articles of furniture the exact converse to the case of the column is required, as in the legs of chairs and tables, etc.

² Examples of this effect should be looked for in buildings where pilasters only and not columns are used, for when they both occur the apparent upward expansion of the pilasters is enhanced by the contrast with the tapering columns. Cylindrical shafts also supporting arches do not furnish appropriate examples, on account of the contrast produced by the converging curves of the archivols.

the distance from centre to centre between the columns will seem to be greater on the architrave than in the stylobate, an effect which will become cumulative towards the angles of the portico; and the columns will have the appearance of a fan-like divergence from the base line, unless this upper distance be diminished.

The simplest manner of effecting this is by contracting the distance between the capitals of the extreme columniations, which contraction induces the inclination inwards of the angle columns and of the entire colonnades both of the fronts and the flanks. By this means also a little extra distance from the eye of the spectator is produced, which assists the desired effect.

The remaining inclination in the same direction, viz. those of the faces of the entablature, stylobate, and the walls, are necessary in order that these parts may correspond with the axes of the columns, and have at the same time the effect of giving generally to the entire structure the pyramidal appearance so essential to the idea of the repose of strength,¹ whilst they do not differ sufficiently from the perpendicular to impair the expression of energy. The parts are made to harmonise with one another with so much art that on my first visit to Athens, although immediately sensible of an unwonted perfection in the Theseum and Parthenon, it was only after a considerable time and careful study I could assure myself that the unaided eye could judge which way the columns leaned. Had a single column only been standing, there would have been less difficulty.

3. The *forward inclination* of the antæ which is observed in the Parthenon and Propylæa, but not in the Theseum, may have thus originated. When a tapering column whose axis is perpendicular is seen in combination with a pilaster or anta, of which the sides are also perpendicular, we shall find, if we examine with attention, that the column will appear as though it were thrust outwards at the top; and if the pilaster be diminished in the usual way, so that its face leans away from the axis of the column, this effect will be enhanced. The reason of this appearance is the contrast presented by the different directions of the face of the pilaster and the side of the column contiguous to it. And this contrast in the Greek porticoes would more or less neutralize the advantages obtained by the inclination of the columns.

In the main porticoes of the Propylæa the inclination outwards of the antæ is delicate, and appears exactly calculated to prevent their producing any effect upon the external columns immediately in front of them. In the antæ of the Parthenon the angle of inclination outwards is nearly twice as great as in the Propylæa; and the axes of the columns of the inner porticoes with which they are in juxta-position, although really perpendicular, are by the influence of the antæ made to appear slightly inclined in the same direction as those of the external columns. The outward inclination of the antæ, considered in itself, does not produce any ill effect, for by leaning forwards to shorten the bearing of the architrave it combines with the opposite inclination of the external columns in helping to express a pyramidal character.²

The antæ of the wings of the Propylæa form part of the external walls, and share in their inclination. Sufficient notice has been taken in Chap. IV. of the advantages of the forward inclinations of the acroteria, coronæ, and abaci, etc., which probably originated in these subordinate surfaces having in the first instances been left perpendicular to the general horizontal curve.

The entasis of a column, as it imparts little or no additional strength, is manifestly one of those instances in which, according to the words of Vitruvius, "*blandimur voluptati visûs*" (Lib. III. 2); and the artistic necessity of this feature may either be simply an imitation of the practice of Nature in giving almost invariably a convex outline to the limbs of animals, or it may be derived from optical considerations; some of these I will here attempt to explain.

¹ To a certain extent the pyramidal construction which has been adopted is really, as well as apparently, more stable than if it were perpendicular. But had this been the object sought, the adjustment would unquestionably have been more considerable, for the actual advantage gained in this respect is so slight as in no degree to have repaid the complication introduced in the construction.

The conclusiveness of the argument which rests these adjustments on optical grounds will appear the stronger, if two tetrastyle or other porticoes be roughly sketched side by side, the one drawn with the

adjustments of horizontal curvature, diminution, inclination, entasis, etc., exaggerated sufficiently to become sensible, and the other having all these qualities applied in a contrary direction. It will then be obvious towards which of these two exaggerations the tendency is most to be deprecated.

² These antæ (except in their general combination) are only visible from confined situations, where the spectator cannot form any correct judgment of their deviations from the perpendicular. This is particularly the case in the inner porticoes of the Parthenon, where the great inclination of the antæ, if palpable, would possibly have appeared displeasing.

The attenuated appearance of a tapering column built with straight sides seems to be owing to several and independent causes, which may be considered separately.

- I. The apparent hollowness in the sides of a frustum of a cone or pyramid in any position.
- II. An additional feeling of the same kind when that figure is employed as a column or pilaster to support weight.
- III. Inequalities of chiaro-oscuro.

Firstly, The attenuated appearance of a conical or pyramidal frustum in the abstract, although it depends upon the convergence of the sides, seems to be confined to cases where the angle at the apex is sensible, but small; for on the one hand it seems to be inappreciable in a cylinder or prism, and on the other is but little felt in the Gothic spire, and still less, if at all, in the Egyptian pyramid. The proof of this, least liable to objection, is the appeal to experiment.¹

Secondly, In the case of the column or pilaster used to support a weight, both the upper and the lower diameters, owing to the greater importance of their situations, detain the eye longer, and thereby produce a greater impression of size than any of the intermediate diameters, which consequently appear relatively smaller, and the shaft concave.

Thirdly, The last and by no means the least cause of the apparent attenuation in the shaft of a straight-sided column, is the effect produced by the inequalities of chiaro-oscuro both of the column and of the back ground.

Of a column which stands detached in a portico, the upper part, by reason of the light being enhanced by the deep shade under the portico, and the lower part, by reason of the greater amount of light actually reflected upon it from the ground, will appear brighter than the intermediate parts, and therefore, according to the universally admitted theory,² will appear relatively broader.

The above reasons for an appearance of contraction and weakness in the central parts of the shafts, as well as the real monotony of a perfectly straight line, seem sufficient to have led the Greek architects to the use of the entasis, which, as has been before observed, does not seem by them to have been applied to a greater extent than just to balance the effects of the optical illusions.³

The amount of entasis depended also in some degree on the absolute height, for it is found to be relatively less in smaller than in larger columns. Those of the Parthenon and Theseum have in all other respects nearly the same proportions, but it will be seen from the table in page 43 that their relative entasis, in terms of the length of the shaft, is about in the proportion of 9 : 7. That of the two orders of the Propylæa as 5 : 4. The influence of this modification of the entasis is most felt when the columns are under 20 feet in height; in those of the Temple of Nike Apteros, which do not exceed 12, there seems to be no entasis whatever. I have endeavoured in Appendix VI. Art. 19, to deduce a rule for calculating the entasis of any column, of which the height

¹ The following explanation of the cause of this appearance in a tapering shaft in any position may be proposed, but with considerable diffidence. It will be readily admitted that the eye becomes sensible of an object presented to it, not all at once, but by passing very rapidly over it from point to point. It is therefore reasonable to suppose that it will pass from a small figure to a larger with greater ease than the converse, and will accept the impression which it derives from the former rather than that which is the result of the latter process. Thus in passing from the smaller to the larger diameter of a tapering shaft, and endeavouring to grasp both sides at once, it will receive by contrast a greater impression of the divergence of the bounding lines than they really have; and as this feeling will continue to accumulate as the eye travels along the shaft, the result will be a slight appearance of hollowness. From the comparative difficulty in passing from large to small, this impression will not be entirely counteracted by the opposite feeling generated in retracing the course from the base to the neck. That this effect does not take place when the angle at the apex is large may be partly assigned to the divergence being in this case so marked as to be more correctly estimated, and partly because the eye in its instantaneous action can no longer follow both lines at once, and ceases to be influenced in the same degree by their contrast.

² A good illustration of the effect of different degrees of irradiation

upon the apparent size of objects, is the seeming alternate dilation and collapse in the full moon when "stooping through a fleecy cloud." The apparent attenuation to which a pilaster with parallel sides is liable is solely owing to the causes treated of under the two last heads. How inconsiderable this must be may be gathered from the fact that in the columns of the Erechtheum, of which the diminution is but small, an entasis of only $\frac{1}{100}$ of the shaft, equivalent to an increment of curvature of $\frac{1}{10000}$, is found to be sufficient to correct all the causes of illusion combined.

³ Without entering into the question of the propriety of the use of single columns, we may see that they are removed from many of the influences above mentioned, and do not require so much diminution or entasis. I think it will be generally felt, in respect of entasis, that of the shafts of two monumental columns recently erected in London, namely the column at the bottom of Regent Street and that in Trafalgar Square, the one which has the least entasis is the most pleasing; and we may even extend these remarks to the columns of Trajan and Antoninus at Rome, of course without any disparagement to the superiority of the sculpture of the Trajan column over that of the Antonine. It follows also from what has been said that rusticated columns, in the few situations in which they are admissible, do not require entasis so much as columns with smooth shafts.

and diminution are given, according to the principles here laid down, and agreeing with the Athenian examples of the time of Pericles.

It is unnecessary to enter at length into the reasons which led the Greeks to use in so many instances the conic sections for the profiles of their mouldings. I have pointed out in Chap. V., and elsewhere, frequent instances of the superiority of these figures to the comparatively monotonous circle. We may also feel certain that the perfect continuity of a mathematical curve renders it more beautiful than one constructed arbitrarily by hand (supposing both to fulfil the prescribed architectural conditions). The same regularity of sequence which enables us by geometry to discover the elements of the curve, produces a more correct harmony of light and shade when it is used for the profile of a solid figure. And this is especially the case in curves such as the conic sections, where the law regulating the developments of the curvature is so remarkably simple.¹

In reviewing the entire subject treated of in these pages, when we reflect upon the studied harmony of the proportions, the delicacy of feeling evinced in the optical corrections, and the exquisite taste shown in the selection of the mouldings and in the coloured ornaments so far as they are preserved to us; and above all, the unrivalled sculpture, to which the architecture of the temple served as a glorious frame-work; it must I think be conceded that the architecture of the Greeks is, humanly speaking, perfect. That is to say, if we keep clearly before our eyes the end they had in view, and without confounding their works with the failures which we, owing to our own shortcomings, and in copying their temple architecture on unsuitable sites and for purposes for which it was never intended, have so generally met with, we are bound to confess that any considerable variation from their architecture and sculpture which we can propose would tend to mar their beauty.

The limited aim which the Greek architects proposed to themselves was not owing to any want of invention, but to that consummate delicacy and judgment which required that whatever was attempted should be thoroughly achieved. In this respect we find a perfect analogy in the other arts of Greece.

Plutarch² tells us that the scope of the Greek music was limited in the earlier times, not from any want of invention, but by design; and he expressly observes that the simple delicacies of treatment which in the better ages of art had amply supplied the place of variety of range, were not only lost, but absolutely unintelligible to the novelty-seeking moderns of his own time, of whom he complains that they were accustomed to call it a mere pedantry to attribute any meaning or value to the ancient manner.

We can imagine almost the same words to have been used a century earlier by Vitruvius, to express his regret that the exact and subtle principles of construction to which he occasionally alludes as having been in use among the ancient architects, were abandoned and forgotten in his day.

The same analogy is moreover obviously strengthened by that of the poetry of the Greeks, and

¹ Appendix iv. Art. 13.

² Cap. XVIII. in Wytttenbach's edition.

Καὶ οἱ παλαιοὶ δὲ πάντες οὐκ ἀπείρους ἔχοντες πασῶν τῶν ἁρμονικῶν, ἑνίαις ἐχρήσαντο. οὐ γὰρ ἢ ἀγνοοῖ τῆς τοιαύτης ξυνοχορίας καὶ ὀλιγοχορίας αὐτοῖς αἰτία γεγίνηται, οὐδὲ δὲ ἀγνοοῖν οἱ περὶ Ὀλύμπου καὶ Τέρπανδρον καὶ οἱ ἀκολουθήσαντες τῇ τοῦτων προαίρεσι, περιέλλον τὴν πολυχορίαν τε καὶ ποικιλίαν.

Τρίχορδα γὰρ ὄντα καὶ ἀπλὰ διαφέρει τῶν ποικίλων καὶ πολυχορδῶν, ὥς μὲν δύνανται μεμεράσθαι τὸν Ὀλύμπου τρόπον ἑντερίζειν δὲ τοῖσι ἐν τῇ πολυχορδίᾳ τε καὶ πολιστρόφῳ καταγενομένοις; which may be thus translated:—

It was not from ignorance of all the kinds of harmony that the ancients made use of only a few. Neither was ignorance the cause of so short a scale and so few strings, or that Olympus and Terpander and their followers rejected variety and the use of many chords.

For the instruments being simple and composed of only three strings, are superior to those that are intricate and numerously strung; so that no one can imitate the manner of Olympus; and modern musicians fail by using many chords and intricacy.

Cap. XXXVIII. in Wytttenbach's edition.

Οἱ δὲ νῦν τὸ μὲν κάλλιστον τῶν γένων, ὅπερ μάλιστα διὰ σεμνότητος παρὰ τοῖς ἀρχαίοις ἀπονομαζέτο, παντελὸς παρητήσαντο, ὥστε μὲν τὴν τεχνόειαν ἀντίληψιν τῶν ἁρμονικῶν διαστημάτων τοῖς πολλοῖς ὑπάρχειν· οὕτω δὲ ἄργως διακρίνεται καὶ βαθέμενος, ὥστε μὲν ἔμφρασιν νομίζει παρέχειν καλὸν ὅλον τῶν ὑπὸ τὴν αὐτῆραν πεπτόντων τὴν ἁρμονικὴν διάσιν, ἐξορίζειν δ' αὐτὴν ἐκ τῶν μελιωδῶν. πείθειν γὰρ καὶ τε τοῖς ὁξυαντῶς τι περὶ τούτου.

The moderns reject the most beautiful sort, which for its dignity was most studied by the ancients, so that most of them have no knowledge whatever of enharmonic distances. And they are so sluggish in their perceptions, that they do not consider the enharmonic quarter tone to be even appreciable to the senses, and reject it entirely from their compositions, deeming those to be mere triflers who have any esteem for it.

Aristoxenus, a contemporary of Aristotle, laments that the enharmonic system was beginning to be neglected in his time (L. I. p. 23, in Meibomius's Collection). An explanation of the system itself, here only alluded to by way of illustration, is given in Boeck's *Pindar*, and in the article on music in Smith's *Archaeological Dictionary*.

by the perfection to which they carried those parts of the science of mathematics which they pursued, and on which almost all modern masters have especially insisted. The same reason (viz. perfection in a limited scope) which renders Euclid the most valuable work on which to found other more comprehensive mathematical studies, renders Greek architecture the most fit to serve as the starting point from whence to commence our more varied architectural pursuits, and to be the standard with which to compare our progress.

For though greater range may have been attempted in other styles, and not without success, yet in the only architecture which after the Greek can claim to be proposed as our model, the mediæval Gothic, although the higher aim of the worship under which it flourished has produced admirable results, especially in the interiors of the great churches built in the thirteenth, fourteenth, and fifteenth centuries, yet it contains so many anomalies and sometimes details, for which grotesque is too mild a term, that of all the architecture of the past (without denying to the future the abstract possibility of a still more advanced standard), we may justly confine the high attribute of having (humanly speaking) reached perfection to that of the Greeks.

Greek architecture in its pure state has been tried in this country, but our imitations of it have too often been cold and hard. Nor has this been owing solely to the want of the refined optical principles which have been described. Most frequently misapplication has led to this result; but we necessarily here also feel the want of that power of cast shadow (almost a fourth dimension) which attends and enhances the light of a Southern sun; and which imperatively requires the use of a greater variety of form as the only means of enabling us to attain our object, by the help of shade instead of shadow. But the salutary effect of the study of this architecture upon the works of those who have treated it most consistently shows that pure architecture may and ought still to be our aim.

We must, however, bear constantly in mind that a rigid adherence to precedent has often proved fallacious, when persisted in contrary to that universal rule of common sense which requires that architecture shall be suited to the manners, habits, and wants of the people, and worthy of the science of the day.

This rule however being applied, no course can be proposed so hopeful and at the same time so safe, as that of using Greek architecture for our standard of excellence. Its purity and the limited range of the examples which have come down to us sufficiently secure us against every danger. We shall find it no "exemplar vitiis imitabile;" and the modern architect, in the midst of the uncertainty felt even by the most practical of his contemporaries, may yet congratulate himself that he now has Athens as his guide and not Rome only, as was the case in the revival of classic art. The rude motto of the one

*Tu regere imperio populos Romane memento,
Hæ tibi erunt artes, pacisque imponere morem,*

chills and repels the sympathies of the artist, which expand in admiration of that genius not less faithfully portrayed by the Athenian poet,

*Σοφὸν τι τὸ μηχανόεν
Τέχνας ὑπὲρ ἑλπίδ' ἔχον.*

[Faint, illegible text visible through the paper, likely from the reverse side.]

APPENDIX

I
ON THE GENERAL THEORY OF PROPORTION IN
ARCHITECTURAL DESIGN, AND ITS EXEMPLIFI-
CATION IN DETAIL IN THE PARTHENON, Being
an abstract of a Paper read at the Royal Institute of British
Architects, 13th June 1859, by W. WATKISS LLOYD, Esq.

I
I HAVE undertaken to render an account of the results of some
studies of the Principles of Proportion in Architecture, as exempli-
fied in the Parthenon.

The subject is not proposed as one of mere archaeological
interest, or simply as a curious chapter from the history of the
art; if justice can be done to it, it ought to be something more
—it ought to be a contribution to the scientific aids and resources
of the art, as proving not merely that the Greeks worked upon
such and such arbitrary maxims, but that they had discovered
certain principles. To trace a theory of proportion as employed
by the Greeks in design may be of interest in any case, but
how much the more should it approve itself as having a rational
and scientific basis.

Few here, it is probable, will doubt that the solution of one of
these problems involves that of the other; and whoever can prove
that he holds the explanation of the proportions of the Parthenon,
will be easily absolved from further argument that the system
employed was right and truly scientific; as, on the other hand,
a claim to possess a true theory would have to stand the test
of application to the Parthenon. The general theme of admiration
of all who write and all who speak of the impression of this
temple on the spectator, I have found to be the sense of harmony
that it excites—the pleasurable satisfaction of the feelings
associated with proportion; grace of proportion, dignity of pro-
portion, justness and harmony of proportion, are phrases that
recur in the course of their observations again and again. In
response to what is implied in these expressions, the speculative
have not been remiss in asserting for architectural harmony as
close a dependence on mathematics as has been so long established
for musical. Admitting the justness of the presumption so far,
I may say at once that my own conclusions are quite at variance
with what is often the next presumption, that the ratios of the
diatonic scale have any special value as realised in architectural
forms. I do not find this to be the case; I venture to say I find
it distinctly not to be the case; but inasmuch as wherever
numerous proportions are applied, on whatever principle, those
which are found in the musical scale are sure to occur along with
others, I can quite understand how the coincidences encourage
a prepossessed or precipitate theorist, and flatter to betray.

It will be convenient to state succinctly in the first instance
the most important conclusions, which will then be easily borne
in mind through the process of proof and application.

First, It has appeared that the Greek architect attached the
highest importance to the determination of his dimensions by
proportion, and to the execution of those dimensions with minute
exactness. Accidents and faults apart, for which a margin must
be always allowed, nothing was left to chance, random, or
remainder.

Secondly, Dimensions are proportional, in the customary sense
of the word, when they have a common measure; but it becomes
of importance to decide in what directions they are most appro-
priately taken,—which lines are architecturally characteristic. I
find that the Greek architects brought into comparison dimensions
measured along the same straight lines, or lines parallel, and such
a comparison for convenience I call rectilinear proportion; thus
the height of an entablature may be commensurable with the
height of a column, the breadth of a metope with the breadth of
a triglyph, the height of a naos door with the height of a
pronaos column. Another important form of comparison is
between dimensions taken at right angles to each other, and
such instances will be referred to as rectangular proportions.
Thus it seems obvious and reasonable to estimate the proportion
of an oblong plan by comparative statement of the length and
breadth; no doubt its form might be recorded and communicated
numerically by the statement of the angle of its diagonal with a
side; but the eye does not judge such a proportion by reference
to the diagonal.

The comparison of length and breadth of the temple measured
upon the top step, of the height and length of an apartment, of
the height and breadth of the façade, or a triglyph, etc., are
examples of rectangular proportion.

The direct comparison of areas I only meet with in one, but
that a very important class of instances; I refer to the determina-
tion of the relative proportion of columns by proportion of their
sectional area, a subject which time forbids me to enter upon.

Assuming it to be determined that no dimension shall be
admitted into a design that shall not be proportionate to some
other dimension, either rectilinearly, rectangularly, or both ways,
it still remains to be considered what proportions or what ratios
(using an equivalent expression) shall be adopted. Ratios even
of low numbers exclusively offer themselves in crowds, and are
to be subjected to arrangement and selection. If we commence
with two equal lines, and, leaving one unaltered, alter the other
by continuous diminutions, we shall find every conceivable or
possible ratio occurring between absolute equality, 1 : 1 on the one
hand, and absolute disparity, 1 : 0 on the other. If we pause at
certain stages of the progress, as determined by some principle,

these resting-places will form a scale of proportion, a series of steps by which we may regulate degree of approach to and departure from equality between any compared dimensions or series of dimensions. On what principles are the resting-places to be determined, the scales constructed? I can only give results, briefly and partially too.

First, The design itself will necessitate the adoption of certain ratios from the requirements of purpose and plan.

Secondly, The variety of exigencies demand that the other selected ratios should range pretty widely over the interval to be divided, and give a choice of proportions verging towards inequality as well as towards equality, yet with sufficient interval to preclude confusing proximity.

Without pursuing the analysis further here, I must content myself with stating that the scale by which the Parthenon is regulated, commencing with the ratio 1:6, advances towards equality by ratios preserving the common difference between their terms of 5. Thus 1:6, 2:7, 3:8, 4:9, 5:10, etc. As the scheme advances, the differences become trifling, and the numbers undesirably high, and the scale is made out by the ratios 4:5, 5:6, 6:7, etc., the common members of a primary series. Such a scale is formed by the rejection of the innumerable other ratios, some self-condemned by their high numbers, but others as not required or as interfering with the effect of the most characteristic ratios. Thus, the ratios 1:3 and 2:5 are most extensively and importantly employed in the temple at Bassæ, but are absolutely unknown in the Parthenon. Even of the members of the scale admissible and admitted some are comparatively neglected, while emphasis is given to a few by repetition in many instances, and both rectilinearly and rectangularly, and in applications expressive and important. Such predominance we shall find to be given in the Parthenon to the ratios 4:9, 7:12, and 9:14,—to the first especially. It is to be assumed that the system of making dimensions proportionate to each other, sometimes rectilinearly and sometimes rectangularly, was adopted on the principle that the mind and eye naturally take cognizance of both forms of comparison, and feel satisfaction in both harmonies. What then, it may be said, are their comparative values when they clash? It was the aim and study of the Greek architect of the Parthenon that they should not clash; and we shall have to admire the dexterity and success with which he harmonised the two forms of comparison, so that rectilinear proportions that fall out as happily as if they had been exclusively considered, are found to be compatible with, indeed to be the means of bringing about, rectangular comparisons that are still more effective; but I must leave it for the examples to bring home the value of this principle, and the skill evinced in employing it.

To the examples again I must trust for conveying due appreciation of the strict and logical consistency with which the Greek architect selected the terms of his comparisons; that the length of an apartment should be brought into proportion to its breadth, may be obvious enough, but in the ramification of design divisions are called for which must not be proportioned at random, but can only be correctly referred by a shrewd eye for correlative function and expression. Proportions, to be expressive, must correspond with and so represent natural relations of analogy or antithesis, and it was in the discernment or contrivance of these that genius founded and perfected Greek architecture.

The terms to which a prerogative importance is allowed in regulating other dimensions are, especially—

1. The breadth of the front, from which are derived,
2. The breadth of the abacus, and
3. The lower diameter of the column.

But no subdivision of these into any moderate number of fixed minutes or modules will explain their regulating power, which is

dependent upon variable proportion, upon the adoption of ratios that may be taken from any part of the scale.

The designer of a Greek temple held it of importance to secure a definite proportion of low numbers between the length and breadth of the structure, as taken upon the grand stylobate, whether upon the topmost or on a lower step; a horizontal rectangular proportion. Thus the Parthenon has breadth and length on top step as 4:9, the Theseum the same, but on the lower step, and the temple at Bassæ also on lower step, has the proportion of 2:5, and the temple at Ægina that of a double square.

Equally important, or even more so, was it that the full vertical height of the front, from the pavement of the peribolus to the apex of the pediment, should compare in a ratio of low numbers. In several hexastyle temples, those of Theseus and Bassæ are examples, and, I may add, the western front of the Propylæa, the height of the front is commensurate with the breadth, as 3:4. In the Parthenon we shall find that, besides this grand ratio of height and breadth, which there is 9:14, very accurate rectangular proportions were obtained between other main divisions of the elevation; the check upon multiplying these in every instance was the stringent importance of certain rectilinear proportions which were liable to interfere with them. Of these it appears, from comparison of examples, that the greatest importance was attached to making the height of the column exceed the joint height of the other members, that is, stylobate, entablature, and pediment, by a single aliquot. For example, the height of the column may compare with the complementary height of the front as 7:6, or as 6:5, etc. etc. In other words, the height of the column as compared with complement of height is the larger term in what is technically called a super-particular ratio. The ratio applied in the Parthenon is 10:9, in the Theseum 5:4, equivalent to 10:8. The Sicilian builders never discovered or appreciated this principle, and their effects suffer accordingly.

Thus much for the elevation of the front; but a further arrangement was thought necessary or desirable in the Parthenon, in order to harmonise the column as vertical member with the joint horizontals, the entablature and stylobate, as seen on flank, where from such frequented points of view the height of the roof was not visible or brought into comparison. Accordingly the joint height of the stylobate and entablature on the flank is just equal to half the height of the column; or say, height of column: complement on flank :: 2:1. With what exactness this is the case will appear from the comparison of figures to be given presently. The same ratio holds good in the like comparison in the Theseum, where the entablature received an addition of height from the cymatium, which, as discovered by Mr. Penrose, was returned along its entire length.

It was a further established principle that the height of the column should compare symmetrically with the horizontal spacing of the columns; should, in fact, be just equal to the dimensions from the centre or edge of one column to the centre or edge of a third, measured upon the plan. In the Parthenon this symmetry is applied to three ordinary columns and the two intercolumns included, and the same appears to be the case at Sunium. In the east front of the Propylæa and in the temple at Bassæ an angle column and columniation are included in the comparison, which, in the latter case at least, introduces a difference from the relative contraction of the angle columniation. In the temple at Rhamnus the dimension is taken from the outer edge of the angle column to the centre of the third from the angle; in the Theseum we have a like division, but involving only ordinary columns.

I apprehend that the introduction of these equalities of heights with breadths was found to give repose to the effect of a long range of columns, as a repetition of similar spaces and dimensions, and the principle may be susceptible of wide application, as in

fenestrated compositions. If in the progress of a design we conceive the diameter and spacing of the columns to be settled in the first instance, it is clear that the principle just stated would limit the architect to choice of height among three or four fixed dimensions, and, on the other hand, if the height of the column is assumed, the systems of spacing that are available would be reduced within narrow limits. In point of fact, in all such cases, no one point was settled absolutely until all others were settled. When the result is obtained it appears as if the adoption of one harmony brings about another as a necessary consequence; but this is not an accident, for the decision to adopt the first was made on the very ground that it was compatible with or involved a second; in all such adjustments the search is for those symmetries and proportions which recommend themselves by bringing the richest dower of subsidiary harmonies conducive to the effect required, and no solution is satisfactory until such are found.

One more principle, much taken to heart by the architects of the Doric temples of Greece proper, was to adopt a breadth for the abacus of the capital equal to $\frac{1}{5}$ of the height of the column, or else an aliquot part of the breadth of the temple on the top step, or, lastly, accommodating both conditions. A dimension for this part, however, cannot be adopted lightly, for it decides the diameter of the echinus at its greatest swell, and this must be relative to the general proportions required for the column. At Bassæ the abacus of the front is $\frac{1}{5}$ of the height of the column, but not commensurable with the top step; in the Theseum it is $\frac{1}{5}$ of the height of the column, and also $\frac{1}{12}$ of the top step; in the Parthenon the ordinary abacus of the east front is $\frac{1}{5}$ of the top step, but not commensurable with the height of the column; the abacus of an angle column, however, which is broader than the ordinary, is equal in breadth to $\frac{1}{5}$ of the height of the column, while, on the other hand, it is of course no aliquot of the top step.

Such were the leading conditions to which, by custom of the style, by experience of good effect, or by manifest fitness, the architect's design was bound to conform, which gave a certain guidance at the same time that they gave a certain control; not so much guidance that responsibility for ultimate effect did not rest with his genius, not so much control that genius had not ample range for variety and invention.

We have now, therefore, in the case of the Parthenon, a clear breadth of front of 100 Attic feet, say 101.341, on which to erect an octastyle Doric portico, with diameters of columns proportioned to intercolumns in about the ratio 4:5; and in the distribution of the eight columns we have to take into account that, in accordance with the style, the angle columns are to have a somewhat larger diameter, and the angle intercolumns are to be somewhat more contracted than the rest. The process by which, it appears to me, the architect made the distribution in the present instance, is as follows: the top step had to be divided into seven main segments, five of them being equal, and giving the lines of centres for six columns equidistant from each other, while the two end segments were to be somewhat larger, in order to receive the full diameters of the angle columns—a difference that more than makes up for the contraction of the angle intercolumniation. The problem, therefore, in the first instance, is to assign the degree of excess to the two angle segments, as the breadth of the front divided by seven, after deduction of this joint excess, would give columniation. The seven segments of the step correspond to seven segments of the architrave, each equal, in a general way, to the breadth of two triglyphs and two metopes, except the external segments, which have to accommodate an additional half triglyph. Now, if we deduct the breadth of a semi-triglyph from each end of the step, and divide the intermediate space by seven, we shall find the divisions give us the ordinary columniations with the greatest accuracy. This process, of course, assumes that we know the breadth of the triglyph, and this may easily have been obtained

before the average columniation was absolutely settled, as it is deducible proportionably from the breadth of the architrave.

Triglyph.	Columniation.	Ang. Seg.	Measured.
$101.341 - 2.786 = 98.555 \div 7 = 14.079 + 1.393 = 15.472$			$\left\{ \begin{array}{l} 15.478, 15.367, \\ 15.468, 15.449, 15.531, 15.443. \end{array} \right.$
$228.141 - n = 225.355 \div 16 = 14.084 + n = 15.477$			

We have now therefore obtained the centres of the columns, giving columniation 14.084, which is exactly coincident with a great many as measured, and also with the average of the variations, the principle of which is accurately determinable, but cannot be now discussed. If we divide this calculated columniation into nine parts, and assign four to the diameter and five to the intercolumn, we obtain, $14.084 \div 9 = 1.565 \times 5 = 7.825$, intercolumn; $14.084 \div 9 = 1.565 \times 4 = 6.260$, diameter. The measured diameters give 6.250 and even 6.245, and this may be held a sufficient approximation; still I believe that another principle decided the exact dimension adopted, though the difference may be but little more than the $\frac{1}{8}$ of an inch. Again we are entitled, by the usage of the order, to look out for an agreement between the height of the column and a division of the colonnade on plan. The nearest approximation is given by the dimension on plan that includes three diameters and two ordinary intercolumns, viz. 34.428, but the height of the column is only 34.250, giving a difference of full two inches. Here again, while we are bound to admit that this approximate symmetry was regarded and valued, it is clear that we cannot accept it as governing the dimensions adopted in execution for the height of columns.

I will first go over the scheme of proportions by which I conceive this and the other divisions of the elevation to have been decided, and afterwards give the comparative tabulation of the dimensions as they come out by calculation, and as set down in the monumental survey of the temple made by Mr. Penrose for the Society of Dilettanti, and published by them in 1851.

The proportion of the height of the front to the breadth of the top step is as 9:14. The breadth of the front is to the length of the temple as 4:9, as we have seen; and it is a necessary consequence of these proportions that the height of the front should compare with the length of the temple as 2:7. These therefore are the grand circumscribing proportions of the structure; the only inaccuracy is that the measured height of the front is $\frac{1}{2}$ an inch higher than it should be by calculation; but the actual length of the temple compares with the height thus enhanced in the ratio 2:7, with absolute exactness within $\frac{6}{1000}$ of a foot.

$$2:65.185::7:228.147 \text{ Cf. measured } 228.141.$$

It will be observed that the ratios, 2:7, 4:9, and 9:14, have respectively the common difference between their terms of 5. In the recited order the terms approach towards equality, and the series may be extended by insertion of intermediate and other ratios having the same characteristic, thus—

$$1:6, 2:7, 3:8, 4:9, 5:10, \text{ etc.}$$

It will be found that several of these ratios are repeated with marked intention in the Parthenon, while none whatever are employed in the design that do not belong to the series either directly or as equivalents (as 2:3 = 10:15, etc.) The height of the front thus obtained is divided between height of column and of complement, in the ratio 10:9, which gives 34.288 for the column, to compare with 34.250, the measured height of the angle column. From the complementary height we have now to deduct a dimension equal to half the height of the column, viz. 17.125, to be distributed between the stylobate and the entablature, so that the height of the column shall be just $\frac{2}{3}$ of the height from the level of the peribolus to the base of the ante-fixal ornaments on flank. The remainder of the complementary height belongs to the pediment, and proves just equal to the breadth of the ordinary columniation.

It will be observed that it still remains to complete the horizontal division of the front by apportionment of dimension between entablature and stylobate. The axioms of proportional design, as conceived by the Greeks, require here that the rectilinear proportion adopted shall also bring about or be consistent with a certain number of very important rectangular proportions. On general considerations it may be easily determined to give a larger share of the dimension at command to the entablature; but the question still remains, how much more? How much more precisely, and why? In effect the apportionment was made by giving 6 parts in height to the stylobate as against 11 to the entablature; the ratio 6:11, it will be observed, belongs to the series already specified.

The rectangular proportions conciliated by such division are these: the joint height of column and entablature comes out exactly commensurable with the 100 Attic feet in the breadth of front in the ratio 4:9, which is the proportion of the plan; consequently, as the length of the top step is to its breadth, so is that breadth to the joint height of column and entablature.

Again, by the dimensions assigned by calculation, the breadth of the top step is commensurable with the joint height of column, entablature, and pediment as 12:7 nearly; by the addition—by the adjusting increment, of half-an-inch to the pediment, the comparison becomes exact, with the further advantage of making the height of the pediment equal to one columniation.

Let us now compare the tabulated dimensions as furnished by Mr. Penrose's independent and scrupulous measurements, which are accessible to all, and as deducible by the process I have set forth—

Calculated.	Measured.
14:1: 9:101.341:65.1478 full height of front	65.185
9:10: 30.859:34.288 height of angle column	34.253
10:1: 9:34.288:30.859 complement of front	30.932
65.147 full height as calculated above	65.185
Ht. of Column.	
2:1: 34.288:17.144 stylobate + entablature	17.150 on flank.
11:1: 6:11.093:6.050 height of stylobate	6.058
6:11: 6.050:11.093 entablature on flank	11.092
— i.e. + returned fillet of cymatium	
17.143 joint stylobate and entablature as above.	
From calculated height of front . 65.147	
Deduct calculated entablature 11.093	
“ “ column . 34.288	
“ “ stylobate 6.050	
51.431	
Remainder for pediment . . . 13.716	
Add height of fillet of cymatium only } 0.299	
present in entablature on flank . }	
Add increment, as referred to above . 0.037	
14.052 height of pediment 14.073	
Entablature on front, calculated . . 10.794	
Column, calculated . . . 34.288	
Height from pavement to apex, calculated 59.134	
12:7: 101.341: . . . 59.115	Cf. measured 59.127
9:4: 101.341:45.0404 column + entablature on front do.	
45.046	

With respect to the vertical division of the entablature, the frieze and architrave are made equal within a minute difference, which is given in favour of the architrave, and scarcely amounts to $\frac{1}{8}$ of an inch. The thickness of the horizontal cornice on front is derived from the height of the frieze by the ratio 4:9. It is therefore easy to divide the height of the entablature by 22, and assign 4 parts to cornice and 9 each to architrave and frieze.

9:4: Frieze 4.417:1.963 Cf. measured 1.951.

The perpendicular thickness of the raking cornice with its cymatium, at the apex of the pediment, is derived from the horizontal cornice, to which it is proportioned as 4:3.

I may add here, that the height of the capital is derived from the diameter of the angle column by the ratio 4:9, viz. 9:4::6.378:2.834 to compare with measured 2.833. Again, the breadth of the triglyph is derived from the same ratio from the lower diameter of the ordinary column, viz. 9:4::6.250:2.777. Compare measured 2.766.

The height of the stylobate is determined by the proportions of the elevation, but it still remains to assign a projection for its lowest step. The actual projection, that is the joint breadth of the lower steps, is 4.997, which brings the following relations into harmony—

6:5::6.058 height of stylobate:5.048 projection (4.997).
5:4::diam. of ordinary col. 6.250:5.00 (measured 4.997).

Thus the intercolumn is to diameter as diameter is to projection of steps.

We cannot too highly appreciate the force and vigour that the composition gains by the feeling with which the artist has tempered the horizontality of the steps by the predominance of verticality in their profile. It is by the thickness of the stylobate exceeding its projection in the ratio of 6:5, while that of the column falls below the breadth of its correlative, the intercolumn, in the ratio 4:5, that it acquires an expression of superior solidity corresponding to its function of bearing the columns, though in reality of smaller dimension than a diameter. The effect is assisted and enhanced by the steepness of the top step, the proper stylobate, as compared with those below. The height assigned to it seems to have been derived from the diameter of the angle column by the normal ratio 2:7, viz.—

7:2::6.378 diam. of angle col.:1.822 height of top step (1.814 measured).

We must now proceed to an abstract of the considerations of proportion which seem to have governed the distribution of the plan between peristyle, cella, and divisions of cella. The primary concern is to determine the line of the upper step, or proper base-moment of the cella, relatively to the parallel line of the upper step of the grand peristyle. The anta is placed at such a distance from the edge of the stylobate, that the sum of its breadth and the interval between it and a flank column exactly equals a columniation. To state this differently, the dimension, including diameter of column on flank of anta and interval between them, exactly equals the sum of the diameters of two adjacent columns on flank and the interval between them; and inasmuch as the anta is less in diameter than a column, the difference goes to enhance the interval or void. The process of division is, therefore, the simplest conceivable. Set off on the front from angle of top step a dimension equal to an ordinary columniation plus an ordinary diameter, say 20.34; this gives the lateral distance for the inner angle of the anta; assign a breadth to the anta which has a ratio to the diameter of column as 4:5, and this gives the outer angle of the anta, and the line of the cella step on flank.

The next, and a most important consideration, is the extent of the top step of the cella east and west—its distance from the parallel line of stylobate on either front. Here we find that by continued gradation the interval between step of cella and edge of top step of grand stylobate is made greater on front than on flank, exceeds it in fact at the east front in the ratio of 8:7, being the exact ratio in which the interval from cella wall to flank column exceeds the intercolumn.

8:7::17.138:14.997 . . . (measured 15.00.)
8:7::8.920:7.805 . . . (measured 7.818.)

The artist, however, who decided these proportions had regard at the same time to their compatibility with some others that are of the highest importance; the cella, which was to be distributed among apartments that were required to have definite proportions, could not have its length relatively to its breadth determined at random. Measured on the top step, it has very exactly a ratio of

breadth to length as 7:19; thus, 7:19::71.33:193.61, which varies from measured length 193.733 on flank by deficiency of .123, and this difference seems to be but the reappearance of the error 0.125 that we have noticed in length of the grand stylobate from just ratio to its breadth. The ratio 7:19 seems at first sight unhandsome and undesirable, from the high number it includes, and the great difference between its terms; indeed, had the architect made the lower step of the cella longer by 0.68, it would have had the admissible proportion of 3:8, the change, however, involving a sacrifice of graces which he did not allow himself to be tempted to make. His justification and purpose become readily apparent. If we deduct an exact square from an oblong 7:19, we are manifestly left with an oblong reduced to the ratio 7:12, and this is the division which has been adopted. The breadth of the cella 71.33 is just equal to the dimension from the top step of the posticum to the back of the opisthodomus, including the thickness of the transverse wall of partition (71.334), and consequently the same breadth compared with the remainder of length, the dimension from the transverse wall in the naos to the edge of the pronaos step, necessarily bears to it the ratio 7:12, the same ratio that occupies so important a place in the elevation of the façade.

I believe it to have been in order to help the value of this proportion, that the pavements of the naos and pronaos were made almost exactly upon a level, and thus, when the portal was thrown open, the spectator might easily take both dimensions together within the scope of vision.

From the stringency of the general proportions applied in the opisthodomus it is clear that we must expect at least equal care in the more important naos; it is also clear that, whatever difficulties may have occurred in distributing the naos, they were overcome, not by sacrificing the proportions of the opisthodomus, but by effectually reconciling them. But by this distribution the plan of the proper opisthodomus itself is brought out with depth and breadth very accurately proportioned, as 11:16. The clear interior breadth, on level of the pavement, is 62.570 (viz. $4.380 \times 2 = 8.760$, add $62.570 = 71.330$), and the corresponding depth, as shown on plan, is 43.003. Now, $16:11::62.570:43.016$, a result which may be considered absolutely identical.

The uncertainty that exists, from the condition of the ruins, as to the height originally assigned by the architect to the interior of the naos and of the opisthodomus, hampers our investigation of the considerations by which he decided the distribution of the plan.

I have shown that the architect divided the platform of his cella by a transverse line, which gave an exact square for partition wall, opisthodomus, and posticum, and an oblong of the proportion 7:12 for the naos and pronaos. Assuming the thickness of the flank walls to be determined, the clear interior breadth of the apartments is given, and it remains to place the walls of the door jambs, on either front, at such distances from the wall or partition as to afford plans for the apartments of desirable proportions, and also leave fitting remainders for pronaos and posticum. Accordingly, the pronaos wall is so placed as to make the length of the naos 98.095,¹ which compares with the sheer breadth from wall to wall of 63.01, in ratio 14:9. That is to say, the ichnography of the grand department,—of the naos, has precisely the same ratio between its dimensions, taken rectangularly, that obtains between the breadth of the temple and its full height on front from pavement of peribolus to apex of pediment.

14:9::98.095¹:63.06 (measured 63.01).

This is the third example of a repetition of a special rectangular proportion, on plan and on elevation, and in positions corresponding

¹ A small correction is required here. The distance is 98.145 instead of 98.095, which was derived from measurements given in the first edition—but the difference is of no consequence as respects Mr. Lloyd's argument.

in relative importance; the others being 7:12 and 4:9. The thickness given to the pronaos wall equals the breadth of an abacus, and it happily results that the dimensions from the pronaos wall to the line of lowest step on front is exactly double that from the edge of cella step to the same line of the stylobate returned on flank.

It seems to have been a traditional principle that the hecatompedon, or 100 feet, which, as we have seen, measures the breadth of the temple, should also apply to some manifest dimension of the naos. To the naos specifically the title Hecatompedaean is found ascribed in inscriptions, and we need not look far to find a coincidence as near as the nature of the case would require. The dimension from the back wall of the naos to the centre line of the threshold measures 101.470, to compare with the exact estimate of 101.341; and here the difference of 0.125 (here 0.129) interferes a third time, and is finally disposed of.

I have now reached or rather exceeded the limits allowable for a paper. I am bound to observe that it is due to these limits that I have only been able to exemplify the theory by a selection of instances, and that there is not one application of proportion adduced that I cannot support by conclusive parallels in other Greek works. Although it is only in the Parthenon that all the refinements of the system are employed in all their perfection, yet each appears elsewhere separately, and so distinctly as to leave no doubt as to its recognition. These corroborations, therefore, I have been obliged to pretermitt for the same reason that I have avoided discussing rival systems, and the examination of the extent to which they involve truth, and the points at which, as it seems to me, fallacy supervenes.

Since the last paragraph above was written and read, an opportunity has been afforded me of putting forth illustrations of the Greek theory of architectural proportion as applied in other cases. They will be found in my essay, admitted by Mr. Cockerell as an appendix to his magnificent work upon the temples at Bassæ and Ægina. Other examples are under my hand worked out in equal detail from the materials found so fully in the publications of the Dilettanti Society. The flexibility and practical character, as well as the specific fitness of the system, can only be appreciated after observation of its success in varied application and numerous examples.

It has now become possible, and is a good work to be done by one who will face labour and some other contingencies, to republish all the best records of classical architecture, with measurements made available for proportional comparison by being expressed decimally, and with a well-studied exposition of the organic law of proportion pervading each composition. The designer of classical architecture—to speak of no other style—will never, until this is done by others or himself, feel or indeed be even comparatively safe out of sight of a precedent, and collections of works of genius will have no more noble fate than to be resorted to as pattern-books. Can the continuance of such an abuse be a necessity? The civilisation of the world and the arts that pertain to it were saved by bold resumption of research at the point where the ancient Greek had flagged or been forcibly interrupted; but the genius of the artists of the Revival did less for architecture than for any of the other arts, not excepting sculpture; and the greatest hope of all went down when Rafael, just as he had declared his dream of an ideal, and recognising both the aids and shortcomings of Vitruvius, was applying to the evolution of it, sickened and died. As some compensation, modern architectural students have at least the great advantage of purer Greek models as subjects for study and suggestions of research. Hints are not wanting also that the time is now again full ripe for a renewed effort to roll away an opprobrium inveterate for thousands of years. Signs are abroad of one of those great revulsions of opinion with which taste is ever sympathetic, which periodically cancel for ever,

for all purposes of active mischief, the systematised mistakes of long generations; when this arrives to relieve the world, though it may not be to-day nor to-morrow, no doubt it will bring the refreshment with it of a regeneration of that art which by its nature is ever before us and about us, to plague or to delight, which in its worst phase has all the obtrusiveness of vulgarity, but in its better partakes of the condescension of the Divine.

In the foregoing essay Mr. Lloyd has established all the main proportions of the Parthenon in conformity with his simple scale and with an accuracy to which no other hypothesis which I have met with has any claim. He has also carried the examination successfully into the case of other temples,¹ but it may also be useful to show how little the law so enunciated would interfere with the liberty and discretion of an architect in composing his design, and further that a very simple method would suffice for its practical application. Let it be, for instance, assumed that series A and B contain nearly all the admissible ratios

$$\frac{6}{5}, \frac{7}{5}, \frac{8}{5}, \frac{9}{5}, \frac{10}{5}, \frac{11}{5}, \frac{12}{5}, \frac{13}{5}, \frac{14}{5}, \frac{15}{5}, A.$$

$$\frac{2}{3}, \frac{3}{4}, \frac{4}{5}, \frac{5}{6}, \frac{6}{7}, \frac{7}{8}, \frac{8}{9}, \frac{9}{10}, B.$$

To these, however, should perhaps be added $\frac{1}{2}$ as evidenced in the height of the column of the Parthenon compared with that of the capital; a ratio easily deducible from the first term of series A, and also necessarily $\frac{1}{3}$. It will be noticed that the scale is rather deficient in terms having a large difference, and for the Ionic and Corinthian orders it might be necessary to make some modification; but this is unnecessary in the Doric, with which we are at present concerned, for the quantities most in demand will be found among the terms ranging from 9:4 to 10:9, where there is abundance of choice to conciliate all requirements, whether

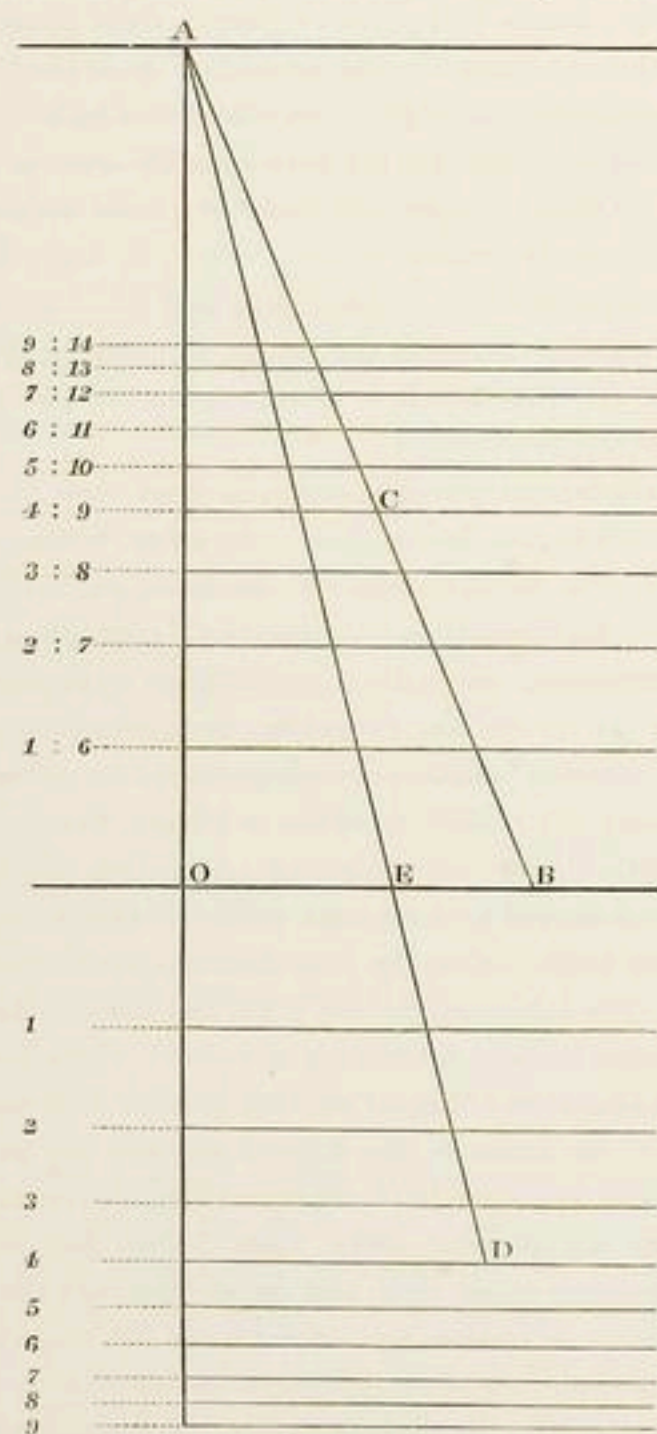


FIG. 22.

arising out of construction or from individual taste and judgment. For in these terms no adjustment that could be required would

¹ Mr. Cockerell's work already cited, and the description of the temple at Priene, *Antiquities of Ionia*, Part 4, published by the Society of Dilettanti.

involve more than a sixteenth part of the smaller of any two dimensions under consideration. It is clear that there would be nothing in the above-stated conditions to take from the architect the initiative which would be indispensable for the exercise of his genius.

The above figure is intended to show the application of the method in practice. Calling *OE* the base, let the upright line *OA* be intersected by horizontals at points dividing it in accordance with the ratios of series *A*—that is 1:6, 2:7, etc. The same proportionate subdivisions being repeated below the base.

In the examples below, the ratio 9:4 has been used, but the method is equally applicable to any of the others.

Suppose firstly, that to a given dimension the corresponding smaller term is desired. Let *BA* on any scale, but not less than *OA*, represent the given dimension. When *BA* is applied obliquely so as to extend from the base up to *A*, *BC* is obviously the term required.

Supposing, however, the ratio not given, but an approximate value desired for the smaller term has been obtained. When *BA* has been prepared and placed as above, the horizontal lines intersect it at all the legitimate places and point out the most suitable ratio. If the inquiry were to find the larger term, the process may be inverted by using *O* for *A* and drawing a horizontal line through *A* as a new base.

Secondly, suppose it were desired to divide a given dimension so that the subdivisions might be to each other as 9:4. Let the total dimension drawn to some suitable scale be placed obliquely with its length *DA* extending upwards from the proper horizontal line chosen from those below the base. Then obviously *AE:ED::9:4*. But if the ratio had not been settled, but the subdivisions *A* and *E* had been approximately obtained, if *AE* be applied as in the diagram, the nearest horizontal line to the point *D* where it extends below the base will point out the proper ratio to be adopted. By means of such a diagram proportions may be adjusted with great facility, and if drawn carefully, and to a large scale, as we may readily suppose to have been done, would admit of great accuracy. The series B can be treated similarly.

II

ON THE EARLIER PARTHENON

2

The restoration of the plan of the earlier Parthenon given in woodcut 20, p. 101, is based on the following considerations, viz.: It may be taken for granted that we have the full extent of the original sub-basement, namely, as stated in Chap. XIV., 104.253 × 231.481. Also that the poros stone architraves give for the ordinary columniations of the front 13.268, and for the flank 12.561; or rather, as slightly corrected for reasons already given, 13.238 and 12.587. The columniations adjoining the angles vary in different examples. In the following instances we have for the ratio of the distance from the angle to the centre of the second column, compared with the ordinary columniation—

	Flank.	Front.
Corinth	1.121	1.200
Olympia T. Jupiter	1.160	1.152
Ægina	1.137	1.137

Here then, for a first approximation we may take these spaces as about one-seventh part in excess of the ordinary columniations, that is to say, about 15.13 feet for the front and 14.39 for the flank. With these data two solutions are possible—hexastyle and octastyle. As regards the latter, there is indeed room for an octastyle temple with sixteen columns on the flank, and with one, or two, projecting steps, which should have the proportion of 2 to 1 between its length and breadth on the upper step; but the width would have been inconveniently great for the sub-basement, and have given absolutely no margin, as there is in the present Parthenon, between the stylobate and the top of the sub-basement wall—a margin which seems im-

peratively demanded by the lower level of the pavement at the base of the wall. Moreover the proportions, both of length, breadth, and height (unless the columns had been much loftier than the date could warrant), would have been unpleasing. The hexastyle arrangement is free from the above objections. It was at the time we are supposing the usual disposition even for large temples—that, for instance, of Jupiter at Olympia—and altogether appears the most probable in all respects; and we may proceed to consider what support can be derived from the measurements given by the marks on the sub-basement to a hexastyle plan with sixteen columns on the flank. Firstly, as respects the front on the upper step—

Take for the margins,	
north and south	$2 \times RS^1 = 34.544$
For the angle columniations	$2 \times CE = 30.108$ 1.1375 columniation = CE.
Three front columniations	39.714
	104.366
The measure of the sub-basement is	104.253
Secondly, as to the flank, also on the upper step—	
Take for the west margin	PR 17.906
For the eastern	YA 20.560
The angle columniations	2AC 29.494 1.173 $\times$ columniation = AC.
Thirteen flank columniations	163.631
	231.591
Measured length	231.481

Deducting the margins we obtain the length and breadth of the temple on the upper step, 193.125 and 69.822 respectively.

It is necessary to try if these values satisfy the almost invariable law which requires that the length and breadth of a temple should bear to each other a simple proportion on one of the steps of the stylobate—generally on the upper or the lower, but the case of an intermediate step is not unknown—e.g. the great temple at Olympia. In the example before us the measurement of the upper step would not be in harmony, but if the quantity 4.16 is added to each the ratio becomes 8:3; from this we infer that the projection of each step should be 2.08, which would not be out of proportion. We do not learn from it, however, whether the temple had two or three steps, but the latter number is rather the more probable; and if, as found in the Parthenon and some other instances, there had also been the narrow offset having about a third or half the height of the principal step, the width covered by the entire stylobate would have been about 4.5. We have seen that in the very exact subdivision of the total breadth it is RS which supplies the measure as far as the upper step. If now the adjoining mark-distance ST be used to fix the bottom of the stylobate, we shall obtain 4.455 for the projection of the steps.

So long a proportion as 8:3 for the length and breadth of the temple is rather unusual, but not without parallel. The length of the Heraeum of Olympia, which also has sixteen columns, bears on the upper step this same proportion, and there are several examples of 5:2. Here also great length was obviously desirable.

The determination of the rest of the plan may be approached in the following manner, viz.: The analogy of a great number of the earliest examples, comprising the two great temples at Olympia, the temples of Corinth, Ægina, and the ancient Cecropium on the Acropolis itself, give for the proportion of the cella, as compared with the entire temple, .752 for the length and .592 for the breadth—numbers pointing distinctly to $\frac{3}{4}$ and $\frac{3}{5}$ as a general rule, though subject to particular modifications. Also we obtain for the proportion, between the eastern and western peristyles, the ratio 661:600, which is obviously as 11:10.

The dimensions resulting from these values in the earlier Parthenon for the eastern, western, and flank peristyles, are respectively 25.287, 22.995, and 13.964. Referring to the marks, we find IM

¹ Referring to the woodcut in page 101.

= 25.246, EH = 22.796, and MO = 14.040. If we use these it will be found that the total length of the cella would be shorter than that of the Parthenon by 50.62 Attic feet of the Parthenon standard.—Compare page 99.

It should now be noticed that for the purposes of this plan we have used the mark spaces continuously, and in a most natural order, from Y to T, interrupted only by HI and OP. As respects HI, when this space is ruled upwards it points out the Pronaos wall both in position and thickness, for HI is practically the same as the breadth of the abacus (7.150) of the larger poros stone capital, and in the Parthenon the thickness of the corresponding wall is equal to the breadth of the normal abacus, and this proportion holds nearly good in several other examples. At the other end of the temple a line ruled upwards from the point T finds the Posticum wall. These two distances, coinciding with H and T, are confirmed by the analogy of Ægina. The measurements derived from that temple would give for AH 52.30, and at the western end 40.20 from the edge of the stylobate. The measures taken from the sub-basement are respectively 52.597 and 39.870.

The columniation of the Naos at Ægina is $\frac{9}{10}$ of that of the flank peristyle, which would here amount to 11.328. IL, which is supposed to have been intended for this quantity, measures 11.357. The internal width of the cella may have been LQ, and the adjoining measure JO the distance between the antæ of the Pronaos and Posticum, and the width of the faces of the antæ themselves KL. OP with great probability may be taken for the breadth of the main stylobate of the flank, and some of the other smaller intervals doubtless represent subordinate parts which we have not sufficient data to determine satisfactorily.

In QS we find a dimension extremely suitable for a very important element, namely, the height of the column. The upper diameter and abacus being known, the lower diameter of the columns of the front cannot differ much from 5.89, the dimension assigned to them in page 89. Assuming that this temple was intermediate in date between the examples at Corinth and Ægina, but nearer the latter, the analogy of those temples would suggest for the height of the column 28.645
If, as at Olympia, it was four times the abacus 28.600
If derived from the mean columniation by the favourite ratio of 9:4, it would be 29.050

The measure of QS is 28.994.

As respects the diameter of the columns of the Naos, the analogy of several temples, Ægina and the Olympian Jupiter included, points out 4.20 as the suitable dimension for this temple, and this is the very measure of the columns of which in page 6 it was mentioned that they had at first been attributed to the Cecropium, before the more recent discoveries had made a different explanation, namely, the Ionic character of the temple, more probable. In the description of these columns it was pointed out that their capitals have a more archaic shape than those which evidently belong to the peristyles and inner porticoes of the earlier Parthenon, but there is nothing surprising in the fact that it should have been so, if the temple was built in a transitional period.

Much confirmation of the vertical dimensions suggested above, and indeed of the whole restoration, is derived from the fact that they conform very accurately to the principal proportional laws stated by Mr. Lloyd in the previous article of the Appendix. We have seen that the length and breadth of the temple would have a simple relation to each other, and if to the existing entablature we supply a suitable cymatium,² and a pediment with the usual pitch, the ratios of height in which these quantities enter will be found to be in agreement with the following rules, namely: (1) The total height of the front, from the top of the pediment to the bottom

² It is very probable that the cymatium exists and is to be found among the fragments recently dug up. It is here supposed to have been 1.27 in height, which is half the horizontal cornice.

of the stylobate; and (2) The same, exclusive of the stylobate; and (3) The height of the order, that is, column and entablature only, should each be exactly and simply proportionate to the breadth of the front; and (4) That between the height of the column and that of the remainder or complement of the front a ratio should exist, differing by a unit only in its terms, the larger term belonging to the column.

	In our restored temple these ratios would be as follows, viz.—		In the Parthenon they are
(1)	4 : 5	55.89 : 69.82	9 : 14
(2)	5 : 7	50.39 : 69.82	7 : 12
(3)	4 : 7	40.12 : 69.82	4 : 9
(4)	15 : 14	28.99 : 26.91	10 : 9

It may be worth while to inquire to what extent the foundations of the older temple would have been available for the Parthenon. It would seem, however, that only in the case of the columns of the Posticum and its transverse wall could any use have been made of them. Nor would an octastyle temple have suited better than the hexastyle.

III

ON THE PROPERTIES OF THE MATHEMATICAL
CURVES REFERRED TO IN THE TEXT.

PLATE XLVII.

3

As I have had occasion to mention some of the geometrical curves which were known to the Ancients, I propose in the description to this plate to enunciate some of their leading properties. The curve represented in Fig. 1 is the conchoid of Nicomedes. Let PP' be perpendicular to XX , S any point in PP' , and let the straight line SP , called the radius vector, revolve round S , so as to intersect the straight line XX at all inclinations, from a right angle at A , till it becomes practically parallel with it, at an indefinite distance on each side of A . If in all such positions as PAP' , QaQ' , the lines AP , AP' , aQ , aQ' , are equal, the line joining all points so obtained, called the locus of such points, is the conchoid; and $v''P''V''$ and $P'SQ'$ are called respectively its superior and inferior branches. Similarly, if ap , ap' , $a'q$, $a'q'$ are always equal, we obtain another conchoid, shown by the dotted lines $v'p'V'$, $v'p'q'$.

We may see from the law of the generation of the conchoid that it is a curve well adapted to be drawn mechanically by continued motion. The conchoid appears to have been first proposed by Vignola for forming the entasis to a column, and has I believe occasionally been so applied in modern times. I have not met with any certain indications of its use among the Athenian artists, but the outlines of some of their vases appear strongly to resemble certain modifications of the conchoid, which also are easily described mechanically.

4

Figures 2, 3, 4 represent the three forms of Conic Sections called Hyperbola, Parabola, and Ellipse. The circle, as is well known, is a particular case of the latter curve. A mathematical cone is supposed to have two similar and infinite parts described about a common axis and meeting at the apex. Every plane which intersects both branches of such a cone forms an hyperbola, and an ellipse if it intersects one only. The particular case which occurs between these two divisions, namely where the cutting plane is parallel to the side of the cone, is called the parabola; and it is indifferent whether we consider it as an hyperbola, formed by a plane intersecting one or other of the two branches of the cone (say the lower) at a given point, and the upper branch at an infinite distance upwards; or as an ellipse, formed by the intersection of a plane with either branch at a given point, and again with the same branch at an infinite distance. The properties of the parabola may therefore be deduced from those of the ellipse or

hyperbola, but it is usually more convenient to consider it as distinct from those figures.

5

The following are some of the properties which are common to all the Conic Sections. XX in Figs. 2 and 3, and DA' in Fig. 4, is the line of the principal axis; S in each case is the point called the focus; QT and QV are respectively a tangent and normal at the point Q ; Pp , $P'p'$ are chords drawn parallel to QT ; and these are bisected by the straight line ff' . PN , QK are drawn parallel, and PM , $P'M'$ perpendicular to XX . The latter are called the ordinates, and AM , AM' the abscissæ corresponding to P and P' . The point from which they are measured, here A , is called the origin. LL' is the double ordinate passing through the focus, and was called by ancient geometers the latus rectum, because they were accustomed to draw it touching the vertex of the curve at A , to serve as a scale for the dimensions of the principal parts. There are various ways of dotting down the Conic Sections by points, a simple one is by means of a straight line, as DD' , drawn at right angles to XX and called the directrix, and the focus S . Let also some definite ratio as e to 1 be given, and draw the straight lines, such as SA , SQ , SP , etc., radiating from S , and let the horizontal lines DS , KQ , NP , etc., be so measured from DD' , that $AS : AD :: e : 1$, $SQ : SP$, etc., being also in the same ratio with KQ , PN , etc., respectively. If the centre be required, make $CA = \frac{AS}{e-1}$ or $\frac{AS}{1-e}$ according as the curve is hyperbola or ellipse; for in the former case e is greater, and in the latter is less than 1. And since $SA : AD :: e : 1$, it follows that in the parabola $SA = AD$. The line ff' which bisects the system of parallel chords, intersects the axis in the point C , which is the centre of the curve, that is, all diameters drawn through C , such as Qq (Figs. 2 and 4) are bisected in C . The point C is obtained by producing ff' in the direction of Q in the hyperbola, and away from it in the ellipse. In the parabola a straight line is given which is parallel to the axis of the curve. The tangent at the point Q , where the line ff' intersects the curve, is parallel to the chords Pp , $P'p'$, etc. The properties of parallel chords are of very great use in determining geometrically the elements of a given conic section.

By the elements are meant the position of the vertex and the direction of the axis of the curve, together with the length of the semi-axis CA (or the distance AS in the parabola), and the ratio of $AS : AD$. The length of the semi-axis is generally expressed in analytical geometry by a , and the constant ratio $\frac{AS}{AD}$, or *eccentricity*, by the letter e .

6

Every hyperbola and ellipse has two foci, H and S , symmetrically placed with respect to the centre. The normal, or perpendicular to the tangent, QV , bisects the angle between all such lines as SQ and HQ produced.

7

To understand the etymology of the words by which these curves are designated, we must first enunciate the equations, or laws connecting the ordinates and abscissæ.

In both the hyperbola and ellipse—

$$PM^2 = \frac{CB^2}{CA^2} \times AM \times A'M.$$

$$\therefore \text{In the hyperbola } PM^2 = \frac{CB^2}{CA^2} \times (2 CA \times AM + AM^2).$$

$$\text{In the ellipse } PM^2 = \frac{CB^2}{CA^2} \times (2 CA \times AM - AM^2).$$

Since $\frac{CB^2}{CA^2}$ is constant in each particular curve, it follows that the square of the ordinate varies as the rectangle produced by the principal axis with the abscissa, with the addition, or *ὑπερβολή*, in one case, and the subtraction, or *ἐλλείψις*, in the other, of the

square of the abscissa. In the parabola it is evident that there can be neither ὑπερβολή nor ἑλλειψις, but exactness of variation, hence παραβολή.

It is easy, however, to prove independently that in the parabola $PM^2 = 4 AS \times AM$, i.e. the square constantly equal to four times the rectangle with which it is compared.

8

We need not hesitate to allow to the builders of the Parthenon a practical knowledge of the greater part, if not all the above-mentioned properties; and I shall endeavour to show that they had some acquaintance with another property, which presupposes a still more advanced state of science.

At every point of a curve varying according to a given law, there is always some circle which has the same tangent, and approaches more nearly to its curvature than any other circle that can be drawn. This is called the circle of curvature, or the osculating circle, at that point in question, and its radius is called the radius of curvature. Calling the radius of curvature ρ , it can be proved that at any point Q in a Conic Section $\rho = \frac{QV^3}{SL^2}$, and at the vertex $\rho = SL$.

It has been pointed out in Chap. VII. pp. 48-50, that in the Doric capitals of the Parthenon and Propylæa, the curvature of the echinus above the point A (see Plate XIX. Figs. 1, 3, 4), follows that of the osculating circle at the vertex A . This perhaps might have been found tentatively, but it is less probable that it should have also been found so accurately as it has been at P , in Figs. 1 and 5 (Plate XIX.), which points are at some distance from the vertex, without some general rule.

It is clear from the fifth book of Apollonius Pergæus, that in the Conic Sections, the curve now called the evolute, which is no other than the locus of the centres of all the circles of curvature, must have been known to him, as it is the limit between the two spaces which he there determines; from any point in one of which, four normals, and in the other, only two, can be drawn to the curve. But it is remarkable to find indications of a knowledge of the radius of curvature in the Greek temples at Athens so much anterior to the time of that great geometer.

9

There are several methods of describing the hyperbola by continued motion. I will mention one which occurred to me while considering the curvatures of the Greek mouldings, and by which I have succeeded in drawing it with almost as great precision as the conchoid. It depends on the following property of the curve. (See the left hand branch of Fig. 2 in the plate). If $W'J$ be a straight line intersecting the curve in I and W , and its asymptotes in W' and I . Then will $WJ = IW'$.¹ Draw IE' parallel to CR , and WE parallel to CR' , then will WE' also equal WE . If we fix a straight line or rule as CR' , and let the triangle WIE' , carrying the produced line $E'G$, slide along CR' , the straight line IW turning about W (as did PP' round S in the case of the conchoid Fig. 1); it is immediately evident that all such pairs of triangles as WIE' , WJE ; wie , wjE , etc., will be similar, and since the base EW , originally equal to WE , remains always the same, they will be equal. That is, $wi = Wj$, for every position of the instrument; thus fulfilling the condition of the hyperbola previously stated. If, therefore, we follow with a pencil the intersection of the radius vector WI , with the line $E'G$, as the latter is moved

¹ This property is easily proved from the laws of the conjugate diameters. A demonstration of it is given by Apollonius Pergæus, II. Prop. VIII. Since the above was written, I met with a work by "Franciscus a Schooten Leydensis de Organica," Lugd. Batav. 1646, in which a method is proposed for drawing the hyperbola, founded on the same property.

along parallel to itself, the curve will be traced out. The demonstration and mechanical construction hold equally good of the other branch of the hyperbola PQA . This instrument is more fully described in the *Builder*, 22d June 1850.

10

The methods of drawing the ellipse are various. A very simple one embodies the property $SQ + HQ = 2CA$. A string is taken whose length = AA' . Its ends are fixed by means of knots or loops upon two pins at S and H . A pencil moving so as to keep the string tight in every position will describe the curve. A better method is by means of the instrument called the trammel. A bar has two pegs fixed upon it, which are made to slide upon two straight lines fixed in a plane, and inclined at a given angle to each other. A pencil placed at any part of the bar will describe the ellipse. The size and form of the ellipse will depend upon the distance between the pegs, the angle which the two straight lines make with each other, and with the position of the pencil on the bar. In the common trammel the straight lines are set at right angles to each other. The advantages, in some cases, of the oblique trammel have been pointed out by Mr. Jopling. It is not necessary that the pencil should lie in the same straight line with the two pegs; but it is generally most convenient that it should do so. A good method of describing the parabola mechanically is still a desideratum. A segment of a parabola may indeed be drawn readily and correctly by an instrument formed on the principle of a cone, but none of the methods that I am acquainted with, in which all the moving parts lie in one plane, are free from objection.

11

I have pointed out in Chaps. V. and VII. various instances of the use of the hyperbola. The parabola has been used in the soffit of the pediment of the Theseum and Erechtheum; the ellipse I have only found in the outline of the painted eggs of the Propylæa. The invention of the Conic Sections has been ascribed to Menechmes, a contemporary and friend of Plato. It is recorded of Eratosthenes (see Montucla, *Histoire des Mathématiques*, vol. i. p. 169) that he called these curves Menechmæan ternaries. It is likely that Menechmes discovered that they were Sections of the cone, or first used them in the solution of certain problems which resisted the power of the circle, but the curves themselves were certainly known in the time of Cimon and Pericles, and I have little doubt much earlier, witness the archaic capitals at Athens and also those at Corinth. It is not unlikely that their first invention was due to the very simple process of setting off a number of distances from a point, and equal distances from a straight line; in the manner already described, Art. 5, when the result would be the formation of a regular curve, viz. the parabola. It would then be an easy transition to make the offsets from the straight line proportional to, instead of equal to, the distances from the fixed point. Thus would the ellipse and the hyperbola be constructed. This being done, the more obvious properties of the curves would gradually be discovered; and their beauty, and the number of accurate proportions, found to obtain in them, would recommend them to the attention of the scientific artists of Greece. Afterwards Menechmes and the mathematicians of the time of Plato, may have discovered that these curves were Sections of the Cone, and were, moreover, useful in solving difficult geometrical problems. Lastly, in the work of Apollonius, the science was so far matured, that Montucla considers it more complete than any work of his own time. Indeed, except the grand discovery of Newton, that these are the only curves in which a particle acted upon by the attraction of gravitation of a central body can move, hardly any of the properties of the Conic Sections seem to have escaped him.

Many schemes have been proposed for drawing the Ionic volute by means of centres of circles;¹ the best of these, as it appears to me, is that given by Mr. Pennethorne in his work on the Geometry and Optics of the Ancients.² None of these methods, however, are quite satisfactory, the multitude of centres are troublesome, and the curve produced by them is developed in an intermittent manner, which is not found to be the case in the best Greek examples.

There is a well-known and beautiful curve, the equiangular spiral, which admits of being drawn by continued motion; but it does not fit the Ionic volute. Nevertheless I believe that the

same end; but for purposes of calculation the Archimedean Spiral is the simpler.) The helix should have a groove formed on its edge, on which a string is wrapped, fastened at the point most distant from the centre, but having a loose end at the other extremity with a loop for carrying a pencil or marker. To draw a capital similar to the Erechtheum or Propylaea, three and three-quarter complete convolutions of the helix will be required, and afterwards an addition which will be described. The first two convolutions will not be wanted except to supply the length of string necessary to commence the operation.

Let the instrument be now fixed near the point intended for the centre of *E*—the eye of the volute—and let two convolutions of the string be unwound, which will bring the marker to *A*,

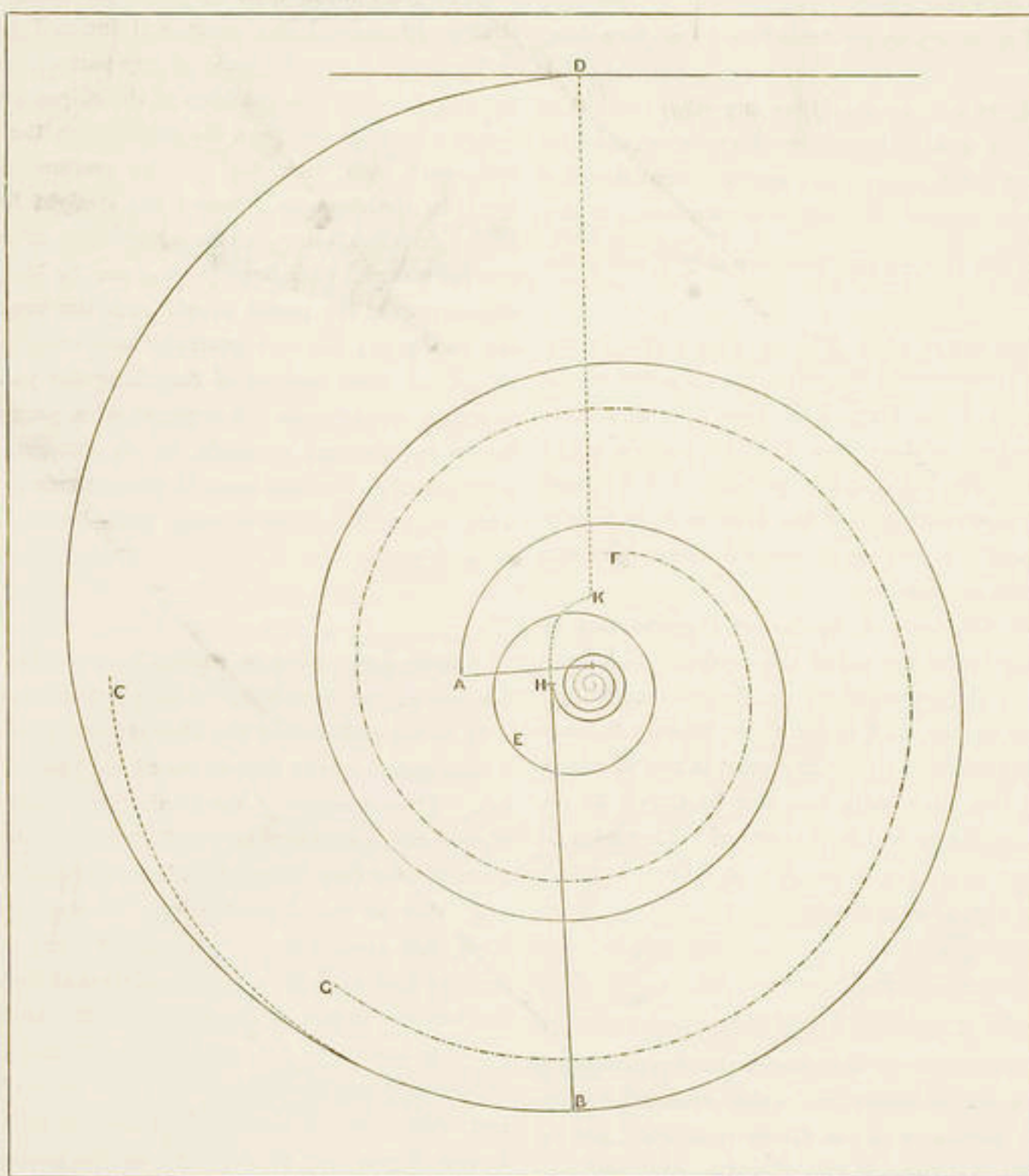


FIG. 23.

latter was so drawn by the simple expedient of unwrapping a string from a spiral helix, carved in wood or some other suitable material, fixed temporarily within the eye of the volute. The diagram above will explain the process. The small central figure represents a curve called the Spiral of Archimedes. It was so named because some of its properties were investigated by that geometer. It is extremely easy to draw by points measured from a centre; for the radii in successive quadrants are to each other as 0, 1, 2, 3, 4, 5, etc.; and any intermediate points may be obtained by subdividing mutually the angles and the increments of the radii. This spiral is not in itself fitted for the volute, because, excepting in the first convolution, it has scarcely any variety, whereas the volute expands rapidly. The small snail-like spiral in the middle of the diagram is supposed to be a helix cut in the form of the Archimedean Spiral. (There is indeed another spiral, called the *involute of the circle*, which would answer the

continue unwinding until the string arrives at *B*, about one and three-quarter convolutions. Thus far, both in the case of the Erechtheum and Propylaea, the coincidence is such as to leave nothing to be desired; but for radii shorter than *A* and longer than *B*, there is a decided discrepancy unless the helix itself be varied as is suggested by the dotted line drawn from *H* to *K*. As respects the curve between *B* and *D*, the unadjusted spiral would have carried the line in the direction *BC*, and the designer of the capital no doubt wished for a more expanding figure in that part, and some modification was also wanted to harmonise the inner portion of the spiral with the eye of the volute.

To form any of the intermediate fillets or channellings of the volute, as for instance that shown by the dotted line *FG*, it is only necessary to turn the instrument partly round upon its centre as a pivot, and refix it.

One volute of the capital having been thus drawn, to obtain the other nothing more was necessary than to reverse the spiral on its pivot placed symmetrically on the other side of the cap.

¹ Vitruv. III. 6.² Page 133.

It is obvious that the carver, whilst at work, could retain the helix in its place, so as to be able at any moment to verify his lines.

IV

ADDITIONAL PARTICULARS RESPECTING THE ENTASIS OF THE COLUMNS

13

The columns have been shown in the different examples produced to have for their entasis the arc of an hyperbola, whose principal axis is small in comparison with the other lines employed.

This kind of curve is eminently fitted to give great variety of curvature. It may be easily proved that in an arc not very distant from the vertex (and such arcs have been invariably used for the entasis), the hyperbola is the only form of Conic Section which can produce, in a small deflection from a straight line, even any appreciable variety. One instance of this is given in Chap. V. Again from the fact that the hyperbola may be so determined as to have whatever curvature we please at the vertex, while at a point at a very moderate distance it may have any desired degree of straightness, we may readily see that under no circumstances can any other Conic Section (and, indeed, scarcely any other simple curve) have so great a variety of curvature in a given change of direction. This was doubtless the quality which so greatly recommended its use among the Greek architects. How they were enabled so completely to solve the problem of its application in practice, as to secure the remarkable proportions among the elements which have been pointed out in Chap. V., and especially in the entasis of the Parthenon, is very surprising. If we were to fix the upper and lower points of the shaft, the amount of the entasis, and the height where it is required to obtain its maximum value, viz. the points *N* and *P* (see Fig. 5, Plate XLVII.), the length of the line *ET* and the height *LH* respectively; it being also given that the axes of the curve are to be horizontal and vertical, as in the case of the Parthenon, or inclined at some definite angle as in other examples; it is possible by the methods of modern analysis to determine the elements of an hyperbola passing through the above mentioned points, and performing the prescribed conditions. But we can hardly suppose that the geometers of the time of Pericles could have solved such a problem; and it seems more likely that the particular curves were found by a diligent selection from a number of careful geometrical drawings of different examples. At the same time a reference to p. 41, in Chap. V., will show how complete a solution was actually obtained.

14

The curve being once (in whatever manner) determined, it would be absolutely necessary, for the correct execution of the column, to form a full sized mould or templet. I will proceed to show how this might be done: referring as before to Fig. 5, in which the curve *NEP* is intended to represent the entasis of the Parthenon.

15

Owing to its great length, it would be difficult to construct the full sized curve in one operation with sufficient correctness, either by an instrument or by means of the focus and directrix, which is likely to have been used in other cases; but it might be done readily, and at the same time correctly, by the aid of a figure of manageable size, see *Apēn* on the figure on the plate, and the representation of its use in producing the full-sized templet *APEN*.

16

In Fig. 6, *RR'* is intended to represent a templet constructed in the manner just described, and brought up by a proper appa-

ratus against the sides of the column hitherto left comparatively rough. The proper position of the templet at the top and bottom of the shaft is secured by means of the small portions of the fluting which have been already executed at the neck and close to the base. It is suggested on the diagram that the drill might be used to point off the work by sinking holes of equal depths, either from fixed points upon *RR'*, or points selected upon the columns themselves. The line of the entasis along the edges of the flutes would thus be formed, from which line the flutes themselves would be sunk by means of other and subordinate templates.

17

In addition to the example of entasis from the Parthenon given in Plate XIV., it may be desirable to subjoin the four following tables of measurements from another column, the third from the N.E. angle of the temple on the north flank, which I found to be in a remarkably perfect state. If the curves be carefully drawn, it will appear, as has been stated in the text in Chap. V., first, that the curvature in the flutes on the outside of the temple is rather more perfect than in those on the inside (in the case of those columns at least where the inner flutes were never visited by sunshine); and secondly, the curvature is more regular along the edges than in the middle of the channels of the flutes.

The measurements are given without any reduction of any kind just as they are found on the column.

TABLE I

Measurements of the Fillet of one of the outside flutes on the north side of the column.

Height above the Pavement.	Offset from the strained wire.
31.35	.062
28.92	.055
25.95	.053
23.10	.052
22.90	.051
19.92	.059
18.42	.063
17.47	.066
14.35	.077
13.40	.081
11.73	.087
10.83	.091
9.19	.100
7.89	.112
6.06	.127
4.29	.145
3.31	.151
3.06	.154
2.28	.167
0	

TABLE II

Measurements of the Fillet of an inner flute from the south side of the column.

Height above the Pavement.	Offset from the strained wire.
31.25	.058
28.88	.055
25.97	.053
23.03	.054
...	
19.88	.057
...	
17.42	.0635
14.30	.0795
13.35	.086
11.33	.0895
9.57	.093
8.87	.098
...	
6.27	.127
6.07	.126
5.32	.1345
...	
1.54	.1655
0	

Table III

Measurements on the inside of the channel of a northern flute.

Height above the Pavement in both cases.	
.102	31.2
.084	28.88
.085	25.92
.086	22.98
.093	19.90
.101	17.45

Table IV

Measurements on the inside of the channel of the opposite flute on the south side.

Height above the Pavement in both cases.	
.102	31.2
.084	28.88
.085	25.92
.086	22.98
.093	19.90
.101	17.45

Height above the pavement in both cases.		
.111	14.63	.1095
.125	11.56	.128
.129	10.31	.1355
.138	8.97	.1415
.146	7.47	.1555
.156	6.08	.1635
.157	6.06	
.170	4.82	.173
.186	3.14	.1885
.196	2.14	.196
.207	1.14	.207
o		

I measured the entasis of three other columns of the peristyles, including one of the angle columns, and am perfectly satisfied of the general identity of the curvature in all cases. The flutes constantly in shade seem to have been pointed off in two or three points only, besides the base and neck, and finished between these points in straight lines or nearly so; those on the exterior of the temple, and in other situations exposed to the sunlight, must have been pointed off at least at every bed joint, that is in ten or eleven places in addition to the base and neck.

The following table of measurements along the fillet of the flute from a column of the Posticum, although from its shattered state they could not be taken in the same satisfactory manner as in the previous examples, will be sufficient to show by a comparison with Table 4 in Plate XIV. that the entasis of the inner order was formed with exactly the same curve as that of the columns of the peristyles.

Height above the Pavement.	Offset from a perpendicular line touching the base.
30.55	.659
26.65	.542
23.21	.448
78.95	.345
16.65	.292
11.65	.196
10.15	.169
9.90	.163
7.94	.120
5.65	.091 rather uncertain.
o	o

V

ON THE LENGTH OF THE ROMAN FOOT

18

It is stated in Chap. II. that .972 English foot is the probable value of the Roman foot. I shall endeavour to establish this both from the measurements of certain ancient standards which I took at Rome for the purpose of determining the Roman foot; and by bringing together the best authorities on the subject. The ancient standards above-mentioned are the three measures of a foot in length, sculptured in relief on marble tombs preserved in the Capitoline Museum, and called the Capponian, Ebutian, and Statilian measures, and two bronze rules which I was allowed to examine, one in the Museum of the Collegio Romano, and the other in the Vatican Library. The three former are not of such a character as to call for the use of a micrometer. In the case of the two latter I made use of that instrument. I found the Capponian foot .967, the Ebutian .976, and the Statilian .972. The general average is .9717. It seemed that the whole lengths of these measures only could be relied on, as the dactyls and uncia are roughly cut, and differ considerably amongst themselves. The bronze hinged rule in the Collegio Romano is well preserved, and seems to have been very neatly made, although it was not very

accurately subdivided. It bears dactyls on one side and uncia on the other. The whole length is .9728. The whole length of the hinged rule in the Vatican Library is .9664; but as the measure is not very well preserved, and especially there is a good deal of *play* in the hinge, while the subdivisions agree tolerably well together, I prefer obtaining the length by averaging two measurements, each containing the 4 uncia which are unaffected either by loss at the ends or by the hinge. These two measurements multiplied each by 3 give .9688 and .9708. The mean value is .9699, thus giving .9712 as the average of the two bronze rules. I also measured one diameter of the Pantheon between the axes of the columns. This measurement amounted to 146.277; but after obtaining the slight differences between these diameters from Degodetz, who has measured between every pair of opposite columns, I find the mean diameter to be 146.14. Assuming this to be 150 Roman feet, we obtain; Roman foot = $\frac{2}{3} \times 1.4614 = .9743$. I also found the breadth of the Portico of the Pantheon on its upper step to be 111.944. If we assume this to be intended for 115 Roman feet, we obtain $\frac{115}{111.944} \times 1.11944 = .9734$; and we may on this hypothesis determine the average length of the Roman foot as derived from the Pantheon to be .9738.

The general average of the above measurements becomes—

3 Marble measures	.9717
2 Bronze measures	.9712
2 Measurements from the Pantheon	.9738
General average	.9722

The best authorities on the subject must now be quoted:—

Niebuhr maintains that the value assigned by Cagnazzi is "not to be doubted," this is .9720

Gosselin from geographical researches (see French edition of *Strabo*, 1819), determines .9721

Böckh (*Über die Masse des Alterthums*) gives a general average of a great many measurements derived by Panneker from Roman sources .9708

He gives .9707 as the value adopted by himself, being the Roman foot as determined by Wurm. But the latter seems to have been in great measure guided by Stuart's measurement of the Hecatompodon, which Böckh himself (p. 199) entirely accepts as the 100 Greek feet. So we must leave out the latter authority in our collation of purely Roman authorities.

The Chevalier Bunsen in his *Beschreibung Roms*, following Zach, gives .9681

This was the average obtained from 28 foot measures; (see Zach, *Correspondence Astronomique*, vol. i. page 335). This astronomer gives, on the authority of the Italian engineer Scaccia, from measurements of CX.

Roman feet, inscribed on a rock at Terracina .9696

Canina, from the Trajan and Antonine columns .9723

Mr. Hussey, in his work on ancient weights and measures, apparently however influenced in some degree by Stuart's measurement of the Parthenon, collects that .9708 is the Roman foot.

If then we average the above-mentioned results, obtained from sources exclusively Roman, we get—

.9723 Canina.
.9722, my own measurements at Rome.
.9720 Cagnazzi, adopted by Niebuhr.
.9721 Gosselin.
.9708 Panneker.
.9681 Zach.
.9696 Scaccia.

General average .9710

This general average differs only by .0018 from the value of the Roman foot determined by taking $\frac{2}{3}$ of the measurement of the breadth of the Hecatompedon, and is quite near enough for the purpose of distinctly pointing out where in the Parthenon this measurement of 100 Greek feet should be taken; for $.9710 \times \frac{2}{3} \times 100 = 101.147$; and there is no integral measurement of the Parthenon that at all approximates to this except the breadth of the front on the upper step, which we may thus feel satisfied was accurately 100 Greek feet.

Perhaps the above value .9710 was as near an approximation to the ratio 24:25 as ever practically obtained between the Roman and Greek measurements. The case of the Egyptian foot is very similar. Its length, which is established from the Nilometer to have been 1.142 English foot, approximates to the ratio 9:8 with the Greek foot, subject to an error of .0017. So that in both these cases there is about the same difference from exactitude in the ratios which obtain between the measures, while they are sufficiently near for the ordinary purposes of commerce. It must be borne in mind that the Egyptian standard of length may be considered as absolutely fixed, while the Roman is uncertain within small limits.

In that case the Roman foot should be .9728, but probably no greater degree of accuracy could have obtained in practice than by making the Roman foot = .972 English foot, which is the value assigned in the text, stamped with the authority of Niebuhr, and I may add entirely confirmed by the average of the measurements which I obtained at Rome.

As respects the Greek foot, besides the measure 101.336 derived from the Parthenon, there seems to have been another standard in use at Athens. Some stones which had fallen from the Erechtheum were observed to have workmen's marks scored upon them, which had evidently been measured with a rule about 1.066 foot long. This measure suggests approximately the length of the standard used in this building, and we find that a considerable number of the more important measurements are multiples of 1.0632. This, then, was probably the length of the foot used in the construction of the Erechtheum, and it agrees well with the dimensions recorded on the well-known report of the Epistatae, so far as they can be followed. Also, from an investigation of integral numbers in the measurements of the Propylaea, the result is identical—1.0631. On the other hand, if we take the lengths of the Theseum and of Jupiter Olympius, each on the lower step where the proportions of length and breadth were adjusted, we find that their dimensions (the former 105×1.01567 and the latter 360×1.01236) conform very closely to the Parthenon standard. A somewhat different measure seems to have been used at Olympia, where the length of the stadium is said to be 192.27 metres, and the length of the upper step of the temple of Jupiter 64.10. From these dimensions we derive 600×1.0513 and 200×1.0515 feet respectively.

VI

ADDITIONAL NOTES ON THE THEORY OF THE CURVED LINES

19

The true amount of the apparent deflection in a pediment, spoken of in page 104, could only be determined by careful experiment, but we shall not err much in adopting the result of many earlier experiments as we find them recorded in the particular case of the Parthenon, and from it we may endeavour to deduce a general law applicable to all other pediments.

If we take a number of different triangles drawn in the form of pediments, it will be evident on looking attentively at them, and especially in the act of passing the eye from the extremities towards the centre of the base lines, that so long as the angles

at the base are considerable (e.g. greater than 30°) there is no apparent deflection. But when the angles are reduced, and begin to take the form of the Greek pediments, an impression will ensue that the base is no longer a straight but a concave line, and that we may draw or imagine a determinate convex curve slightly raised above the base, which shall counteract the apparent deflection and appear absolutely straight. If we proceed to draw the triangles flatter and flatter, the space included between the base and the imaginary convex line just mentioned will appear to occupy a greater proportion of the area of the triangle, until the limiting case, when the angle at the apex becomes insensible, when it is reasonable to assume that the angle of apparent deflection at the extremities of the base of the triangle will amount to half the angle at the base. An exactly similar result would take place if the ratio of twice the apparent deflection divided by the whole angle at the base be supposed to be equal to some function of the angle which equals 1 when the angle is zero, and (diminishing rapidly as the angle increases) becomes 0 when the angle approaches 90° . A power of the co-versine of the angle seems to affect this in the simplest and most uniform manner. Calling then the angle at the base of the triangle θ , and the apparent deflection $\Delta\theta$, (and it will be observed that as the angle $\Delta\theta$ is always very small, the arc which corresponds to it is equal to twice the linear extent of the increment of curvature in the centre of the pediment, and we may also use for convenience, in the denominator, the chord of the angle instead of the arc).

$$\text{We may therefore assume } \frac{2 \Delta\theta}{\text{chord } \theta} = (1 - \sin \theta)^n$$

$$\text{(radius unity) Or } \frac{\Delta\theta}{\sin \frac{\theta}{2}} = (1 - \sin \theta)^n$$

The value of n may be obtained by means of the increment of curvature which was used in the Parthenon where $\Delta\theta = 23'.30''$ corresponding to $\theta = 13^\circ.30'$. The resulting value of n is 10.7, so that the equation $\frac{\Delta\theta}{\sin \frac{\theta}{2}} = (1 - \sin \theta)^{10.7}$ may be proposed for an approximate determination of the increment of curvature in any proposed case. According to this rule, when the angle exceeds 30° the increment of curvature becomes so small as to be practically unappreciable, and the maximum amount of the apparent deflection would take place when the angle = about 6° .

20

The principles which appear to have guided the practice of the Greek architects in determining the entasis of the column seem to be, 1st, That it depends upon the angle of diminution, but in such a manner that its value is on the one hand at zero, when the sides of the shaft are parallel, as is nearly the case in some of the antae, and on the other when the angle is considerable, as in the pyramid; and, 2d, That it depends in some degree on the absolute length of the shaft. In the formation of a rule for determining the amount of entasis in any proposed case; in order to ensure the former condition I use, as in Art. 19, a function of the co-versine of the angle of diminution, and for the latter I introduce into the equation the ratio composed of the height of the shaft above the eye of a spectator standing at the level of its base, divided by the whole height of the shaft.

Let then e represent the linear amount of the maximum entasis θ the angle included between the bounding lines of the column h the length of the shaft, d the semi-diminution, and let 5.5 feet be assumed as the height of the eye:

The following equation will embody all the prescribed conditions

$$e = m \left(\frac{h - 5.5 \text{ feet}}{h} \right) d \times (1 - \sin \theta)^n$$

And the constants m and n must be determined from the measurements of actual examples.

Using for this purpose the columns of the Parthenon and Erechtheum, we shall obtain $m = .19$, and $n = 14$ very nearly. If

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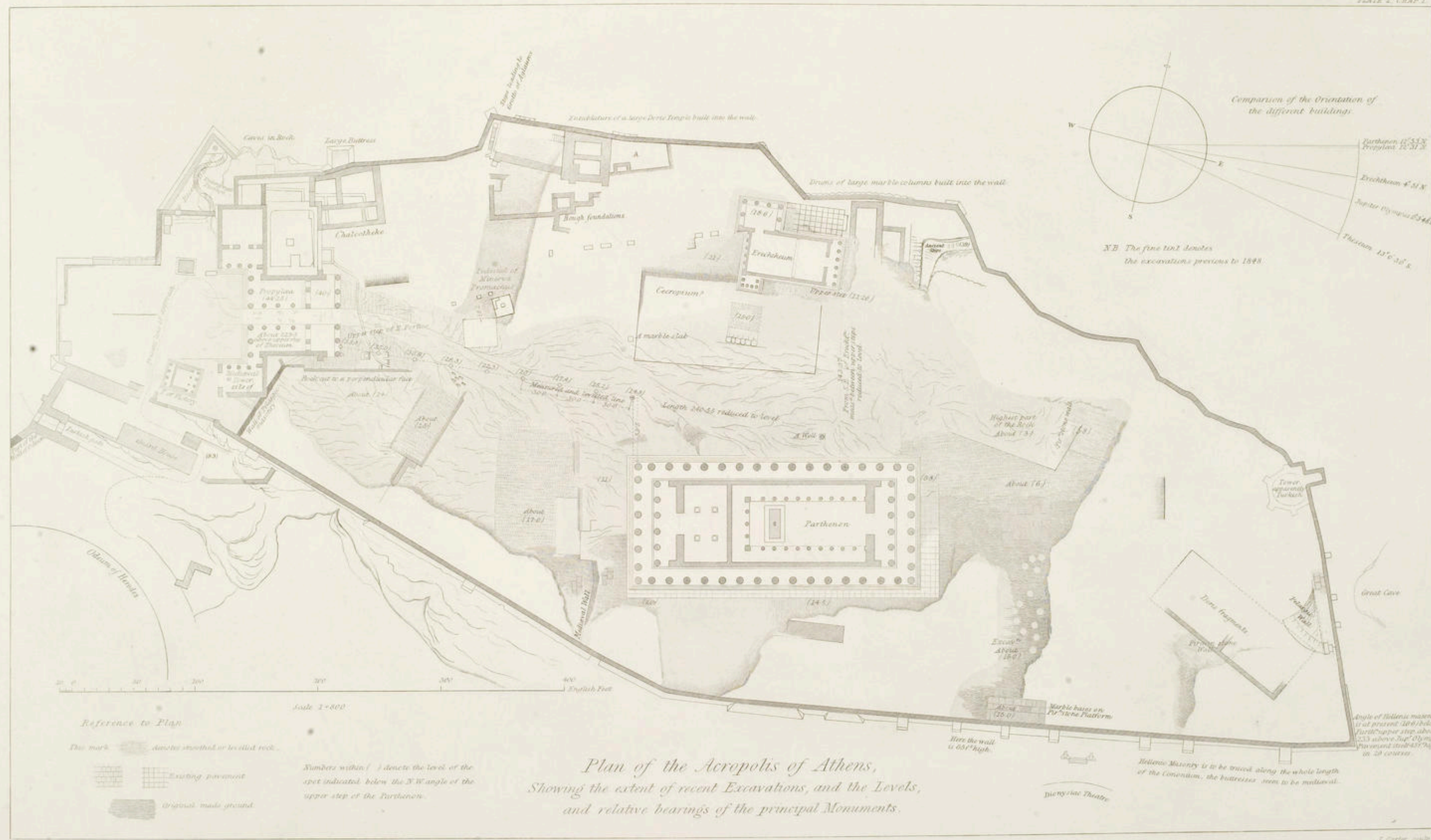
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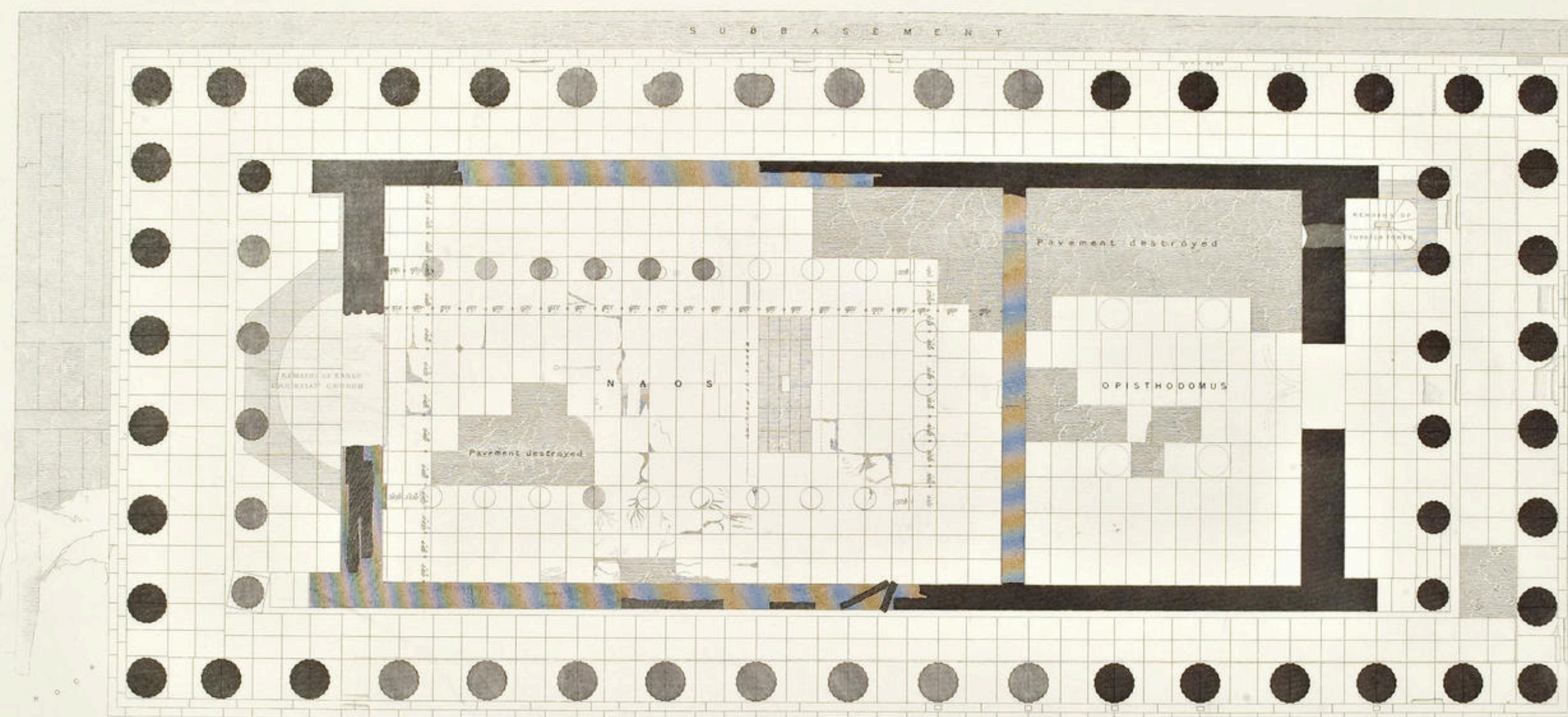


VIEW OF THE
NORTH WEST ANGLE OF
THE PARTHENON SHOWING IN
CHIARO OSCURO THE ORNAMENTS
INSCRIBED ON THE MOULDINGS &
TOGETHER WITH
THE EVIDENCES OF COLOUR.

F.C. Penrose, del.



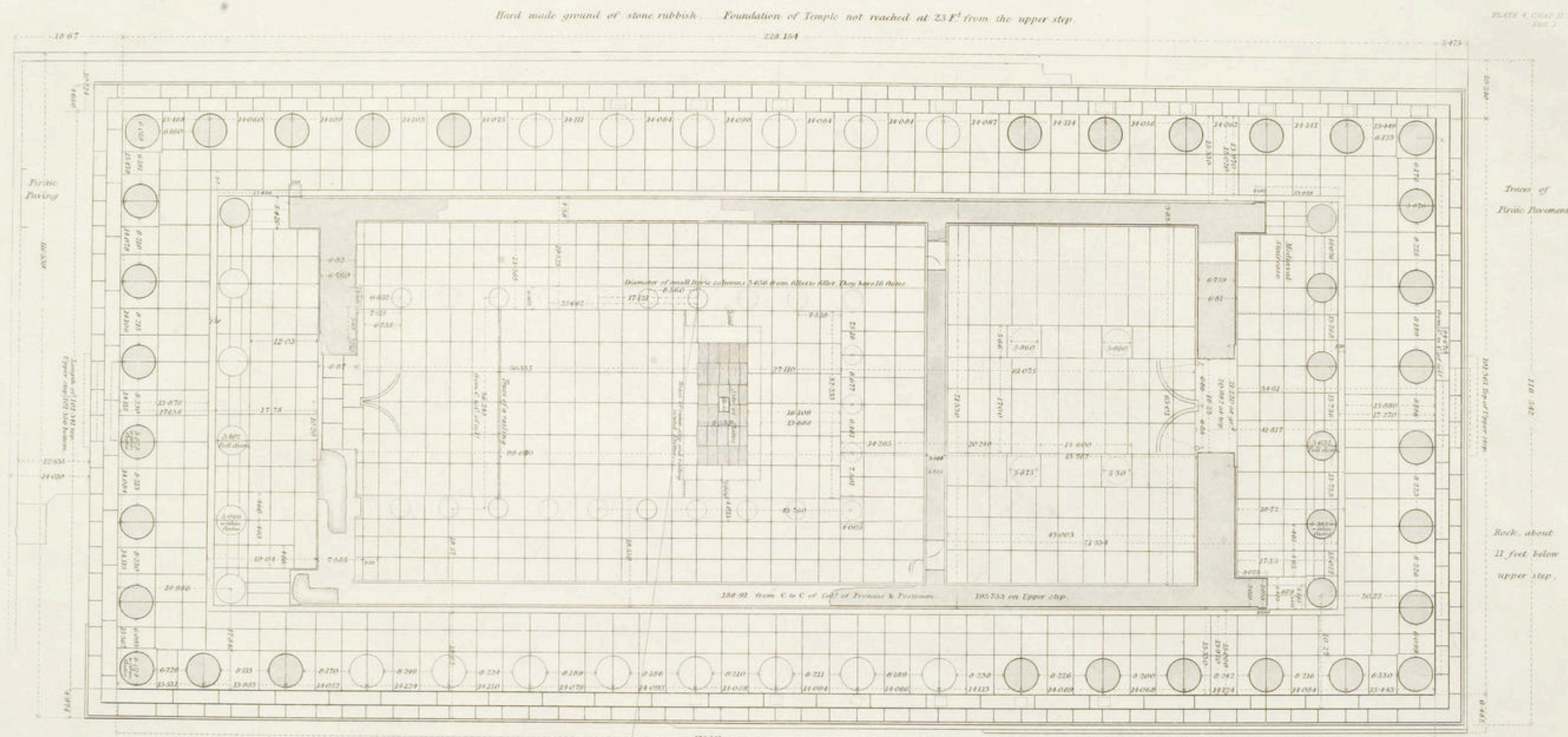
GROUND PLAN OF THE ACTUAL STATE OF THE PARTHENON.

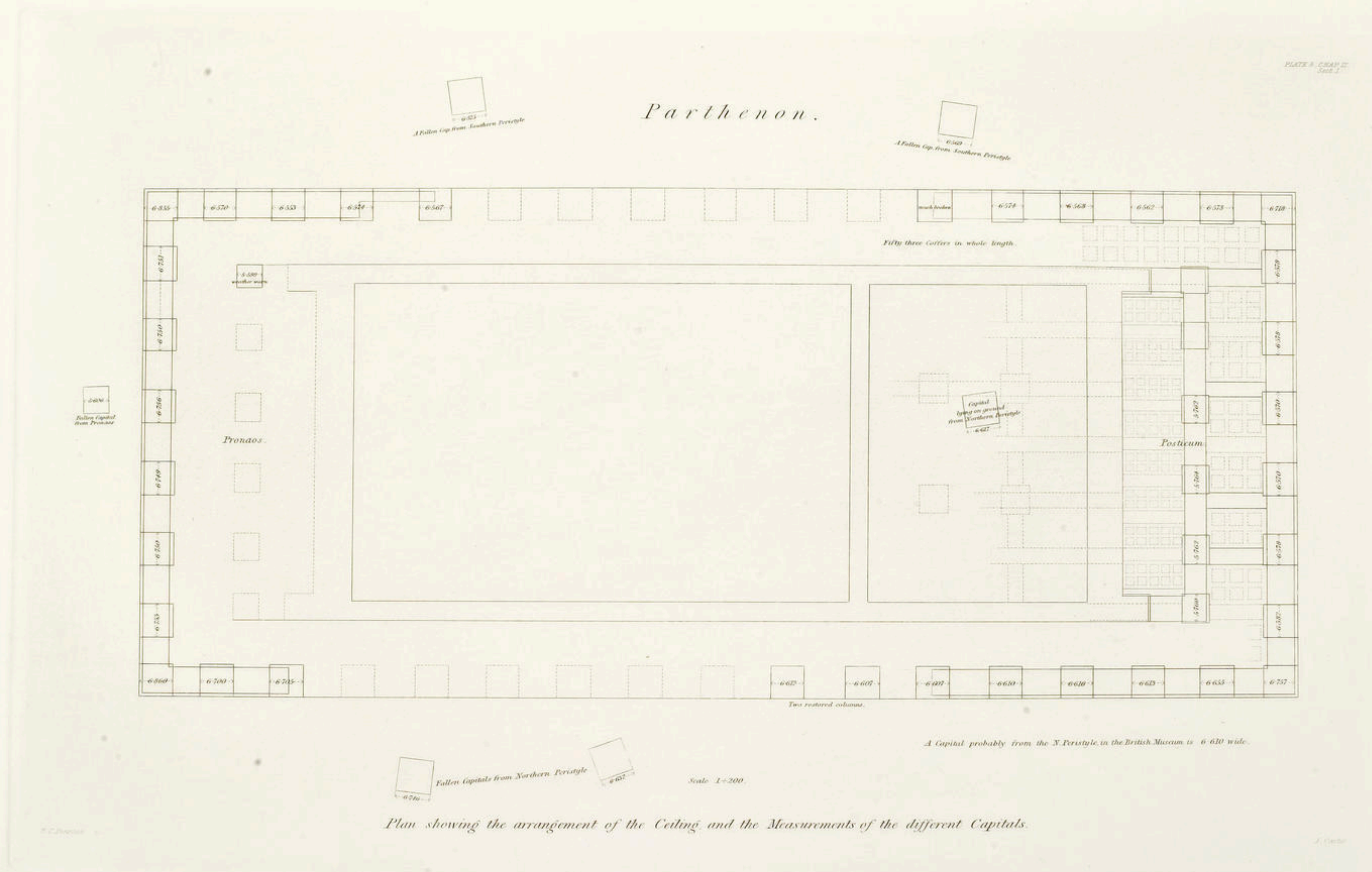


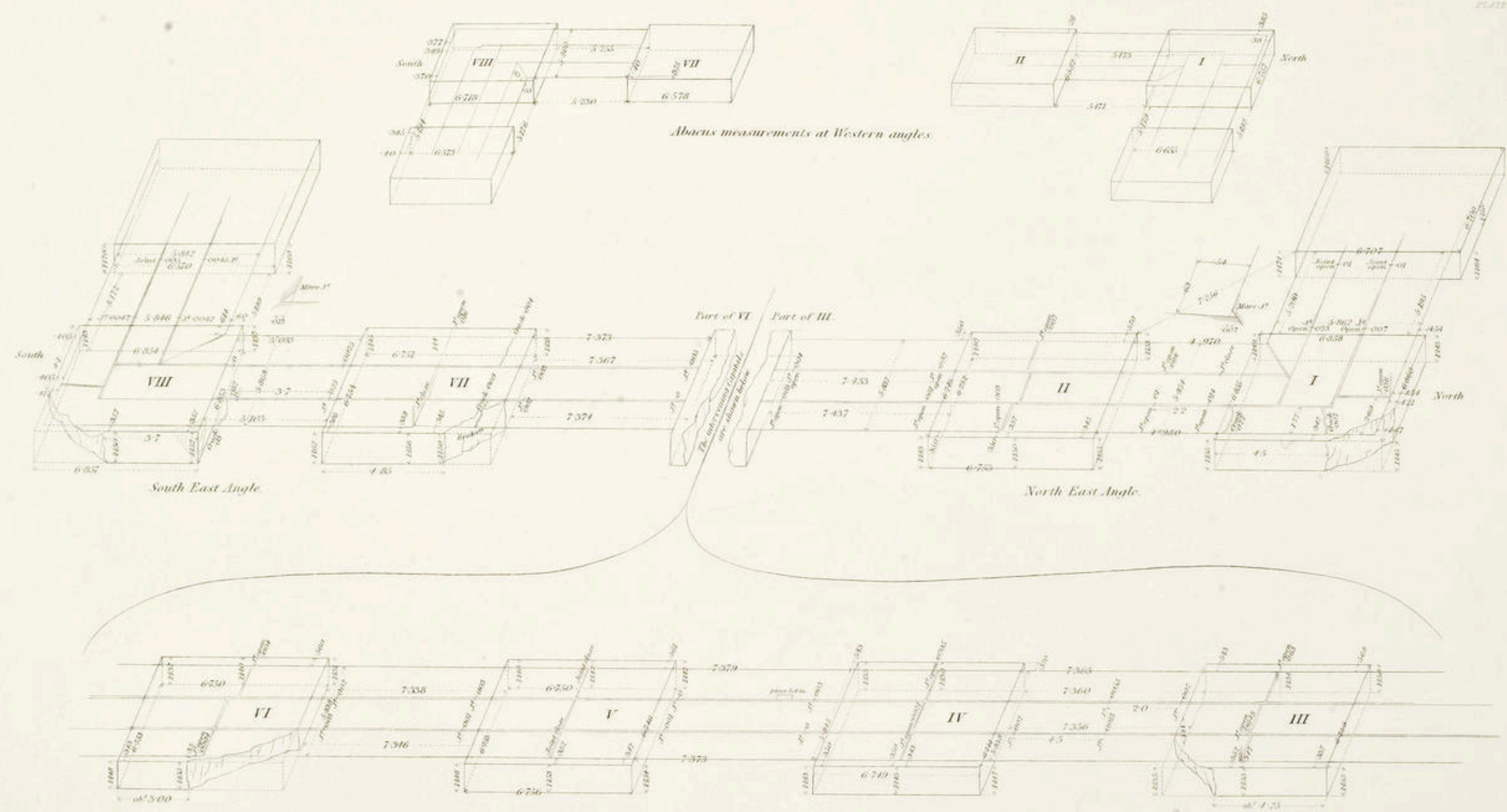
Scale: 1" = 10' 0"

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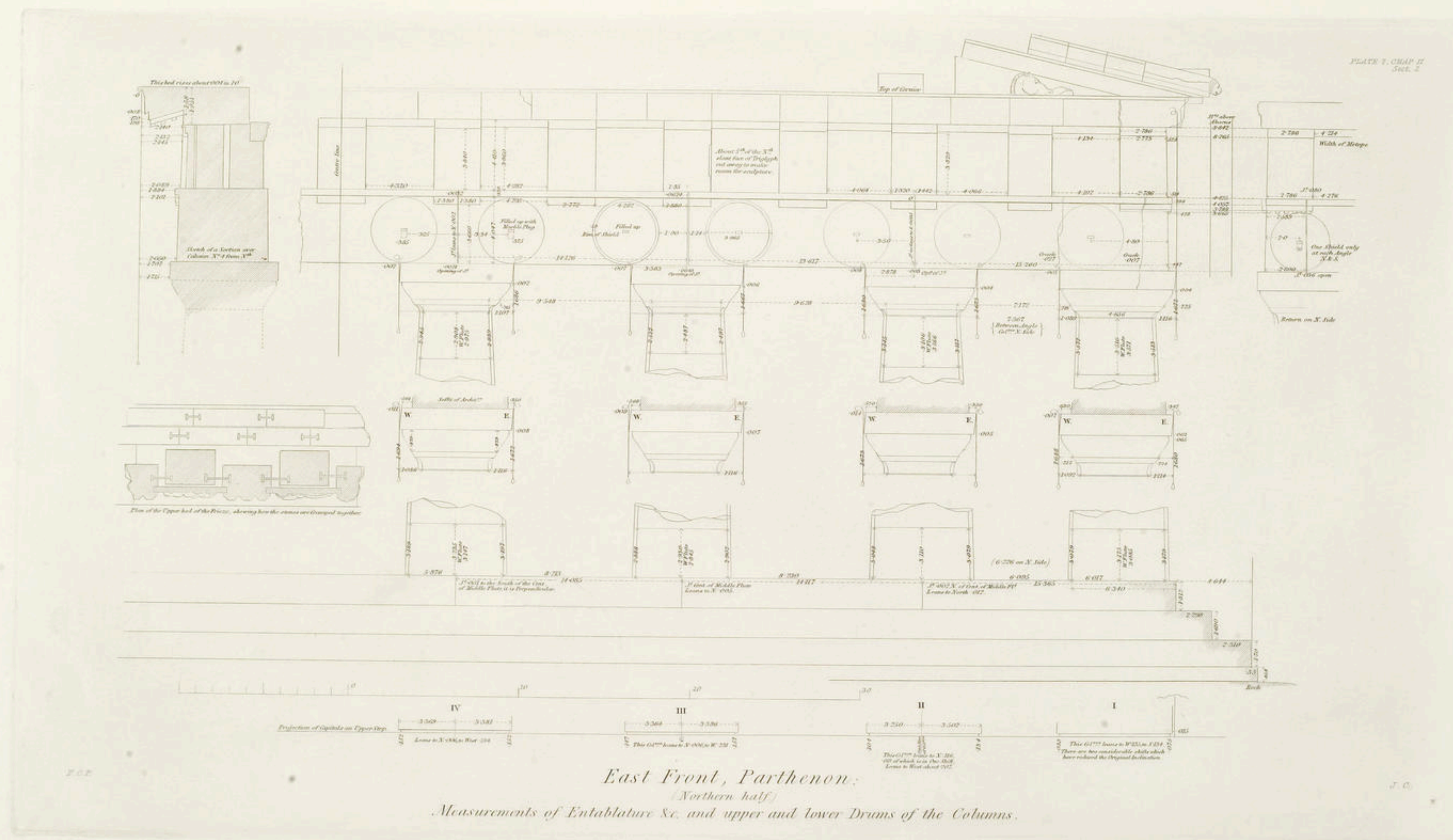
East Front, Parthenon.

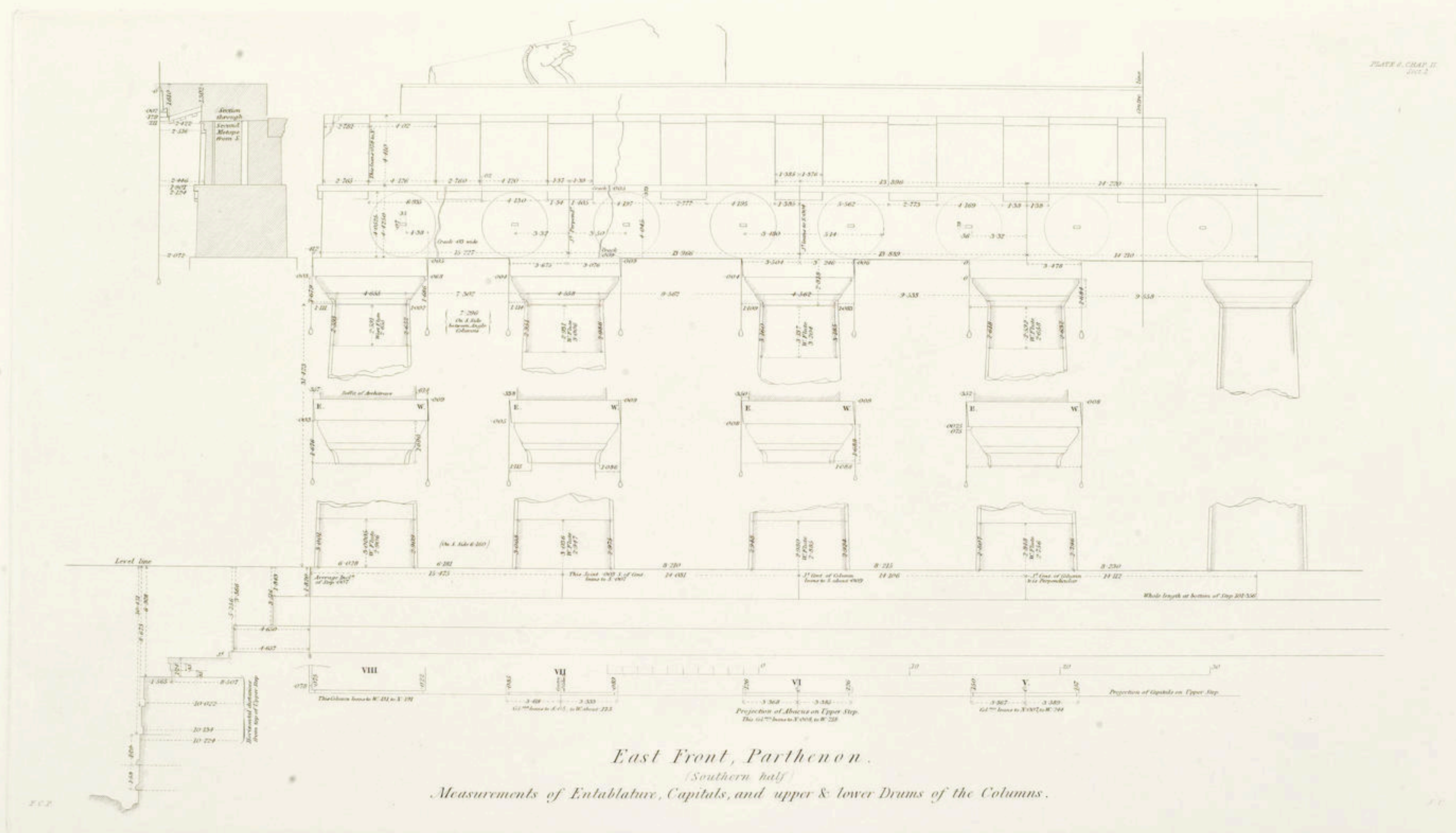
*Measurements of the Abacus and Soffit of Architrave over each Column.
Showing also the cracks and other displacements now existing in the lower bed of the Architrave.*

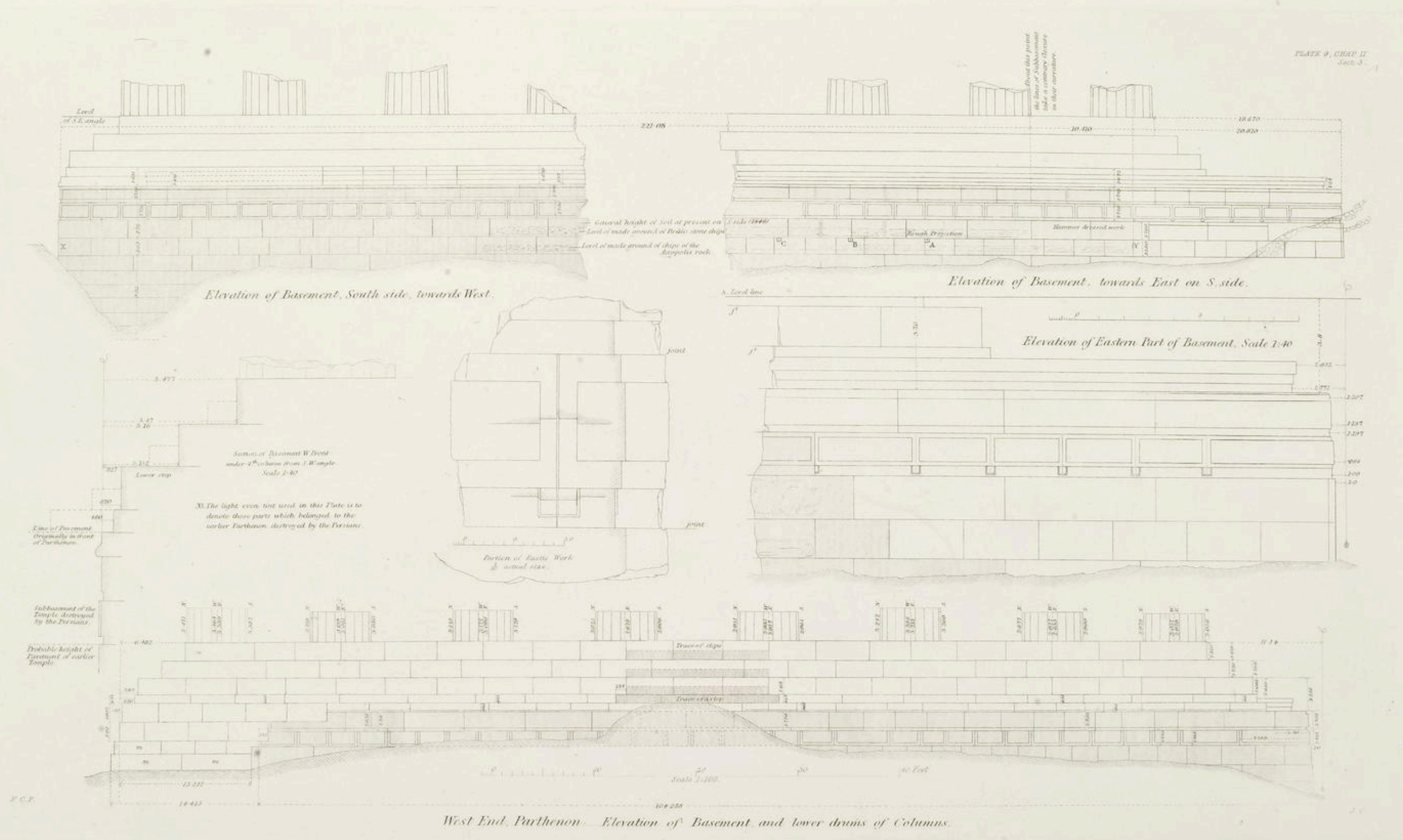
Parallel Scale 1:50. Scale for inclined lines 1:70-71.

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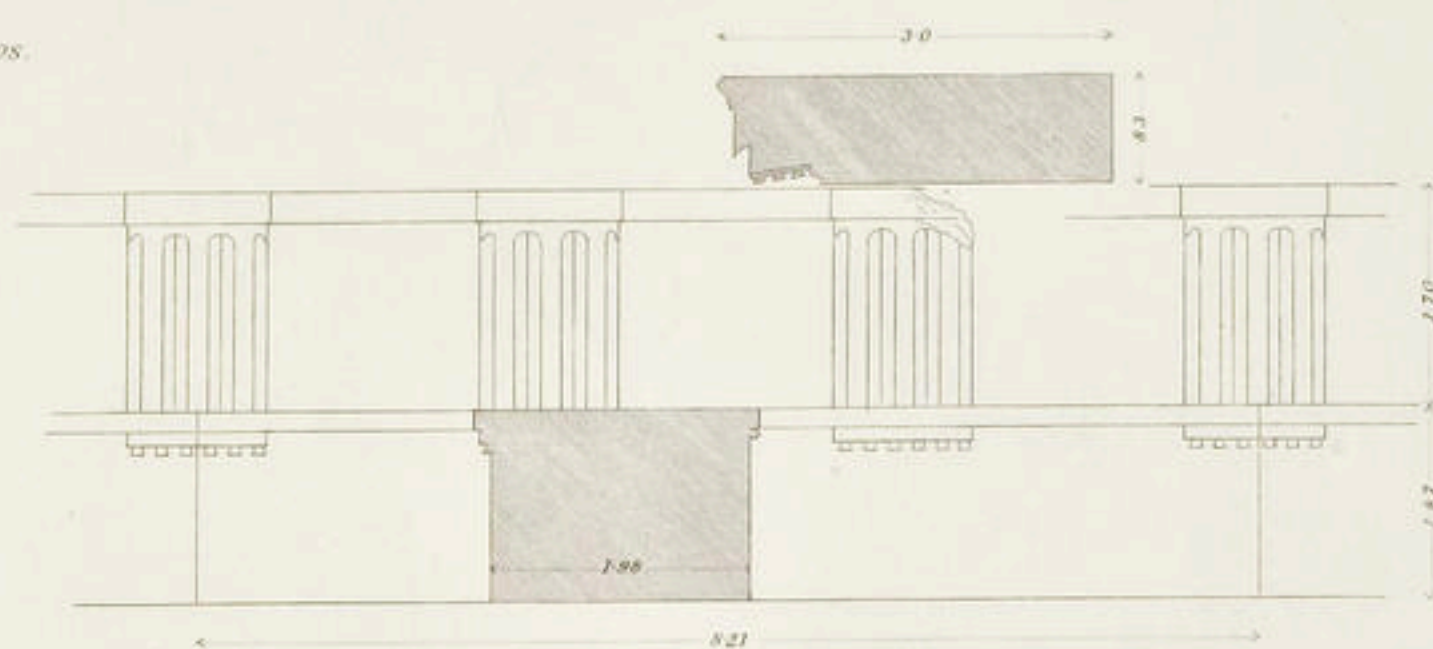
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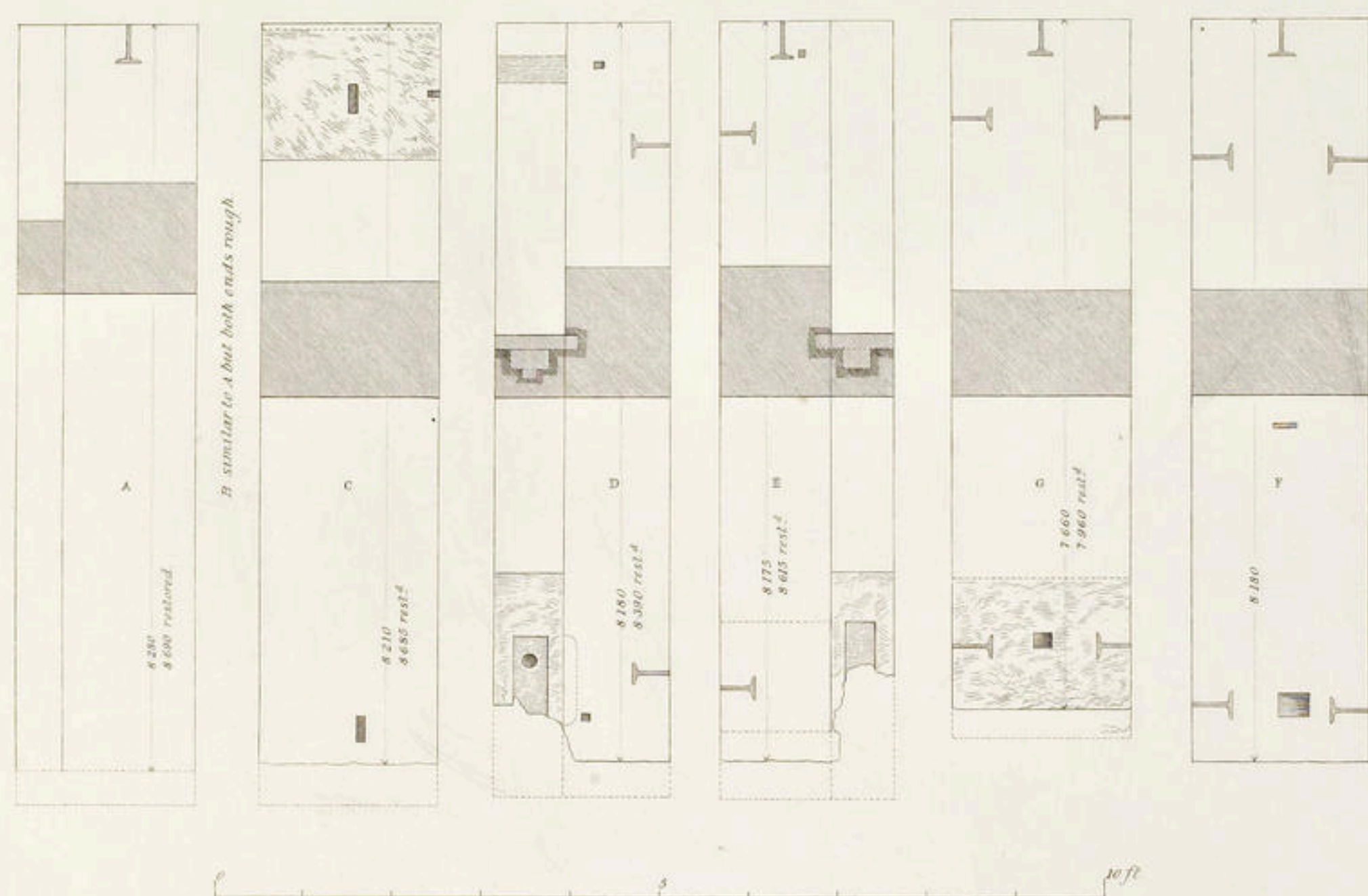




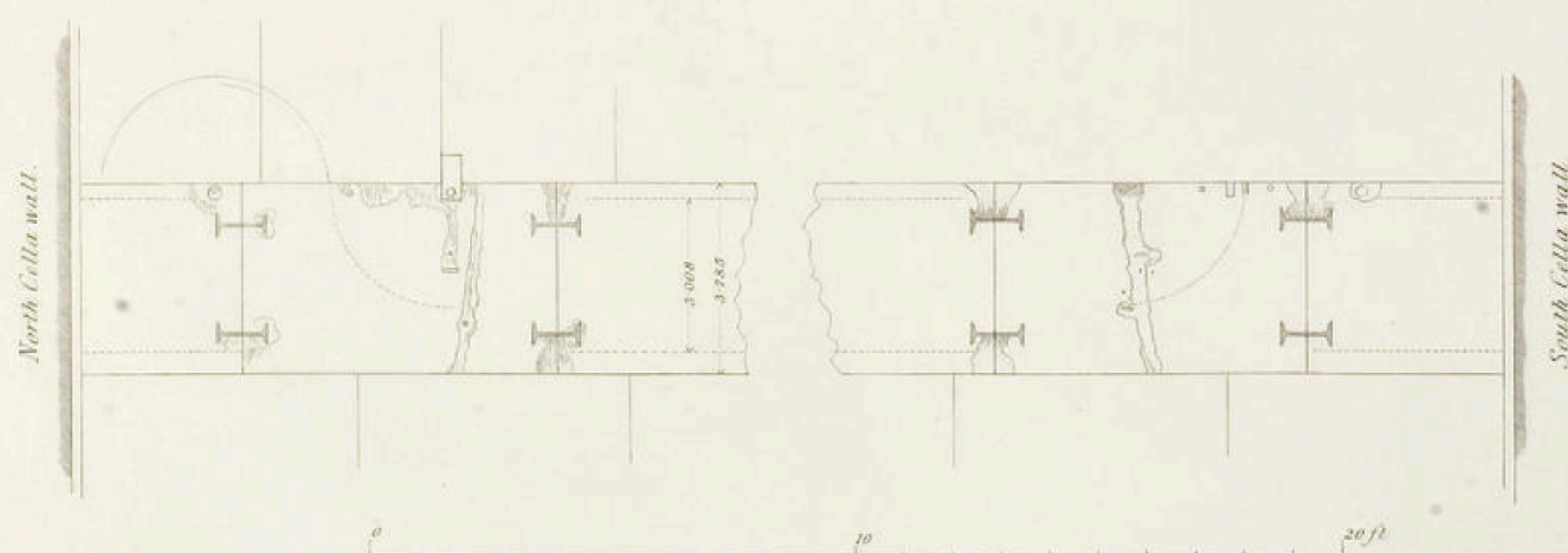
Parthenon.
Details of Naos.



Entablature used in Naos of Parthenon. (Christian period.)



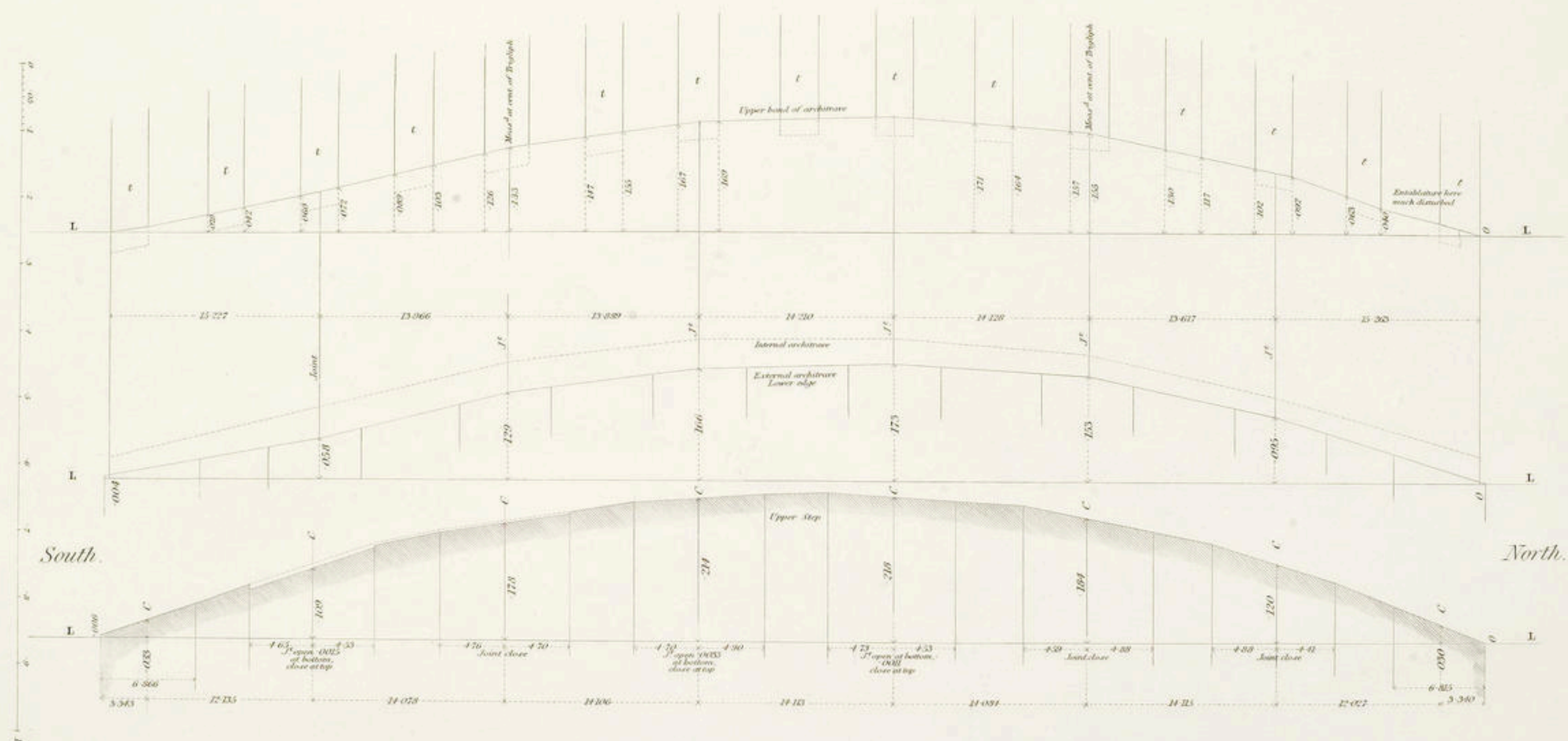
Marble Beams from original Naos.
readapted to shorter columnnade of Christian period.



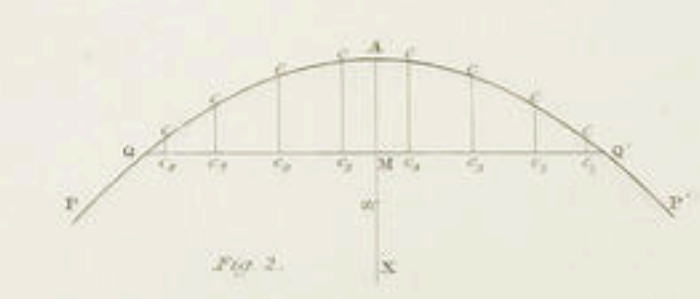
Traces of Doorways between Naos and Opisthodomus

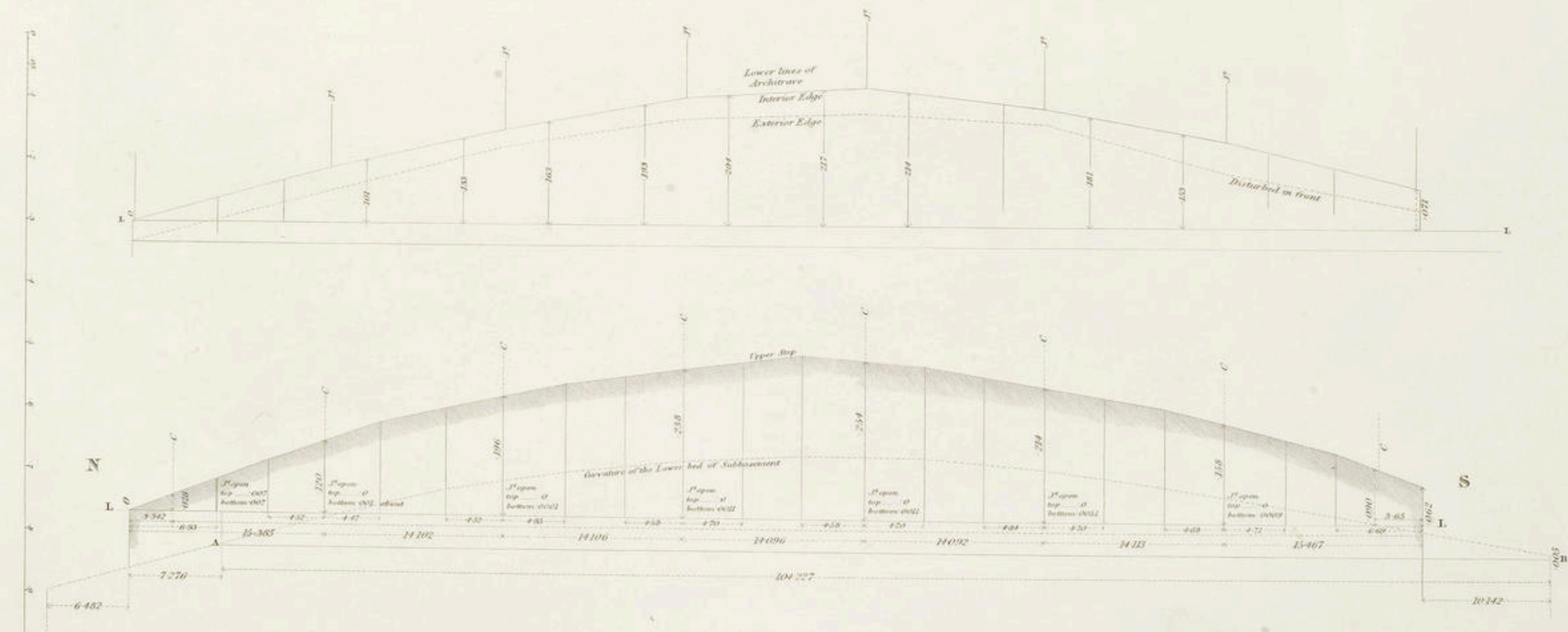
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Gen. Ferriss



East End, Parthenon.
Measurements of the Curvature of the Upper step, and of the Architrave.



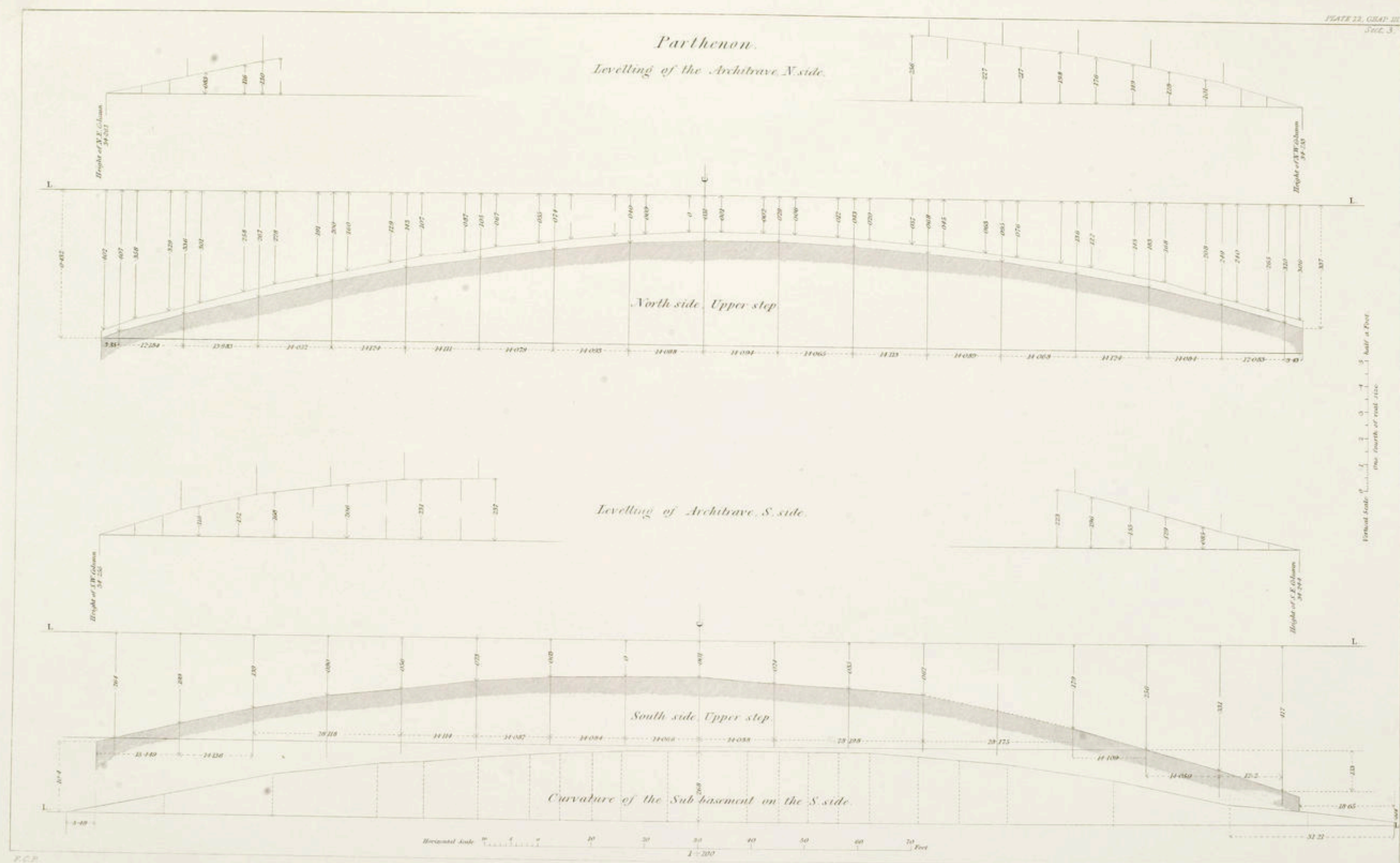


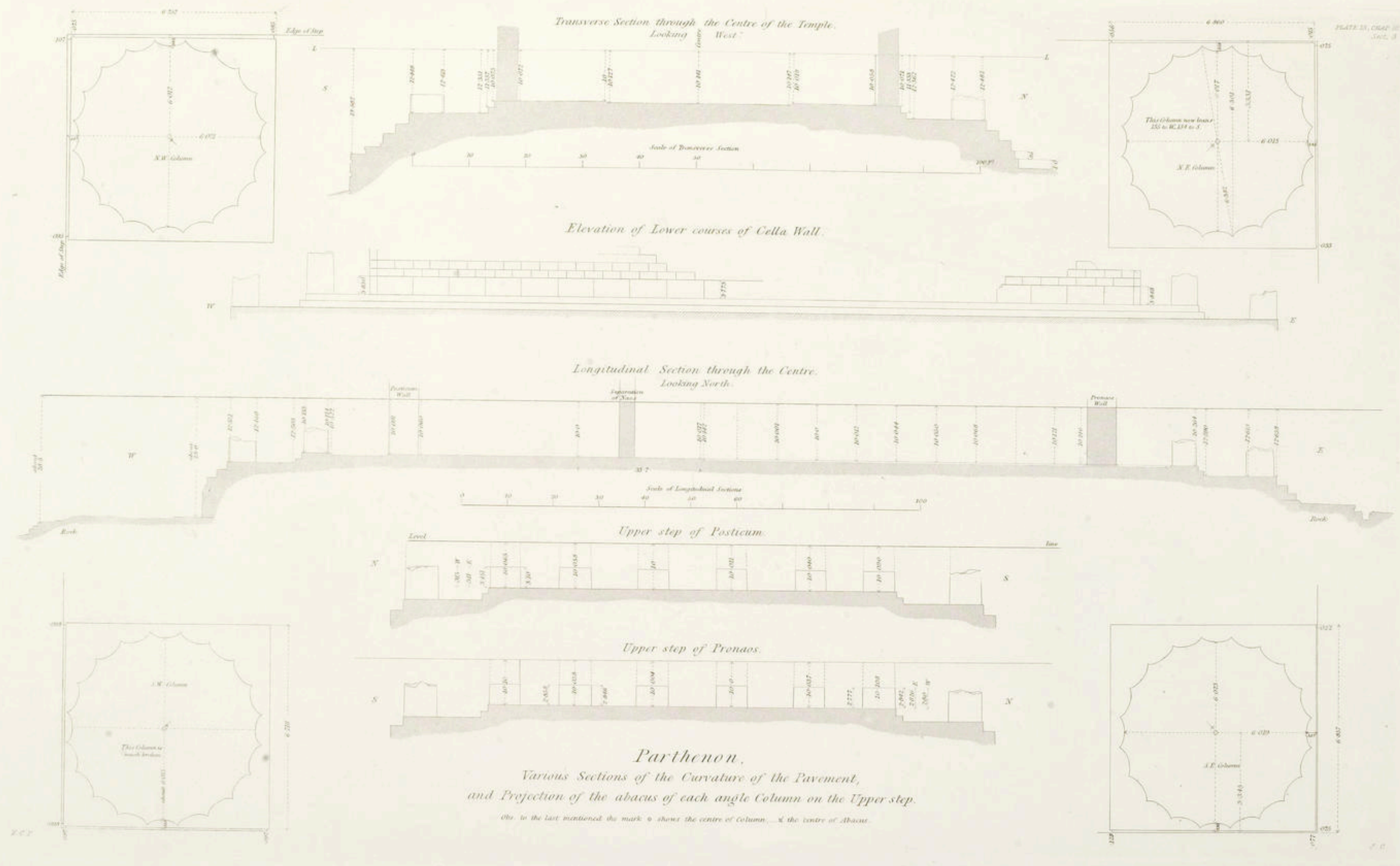
West End, Parthenon.
Measurements of the Curvature of the Pavement and of the Architrave.

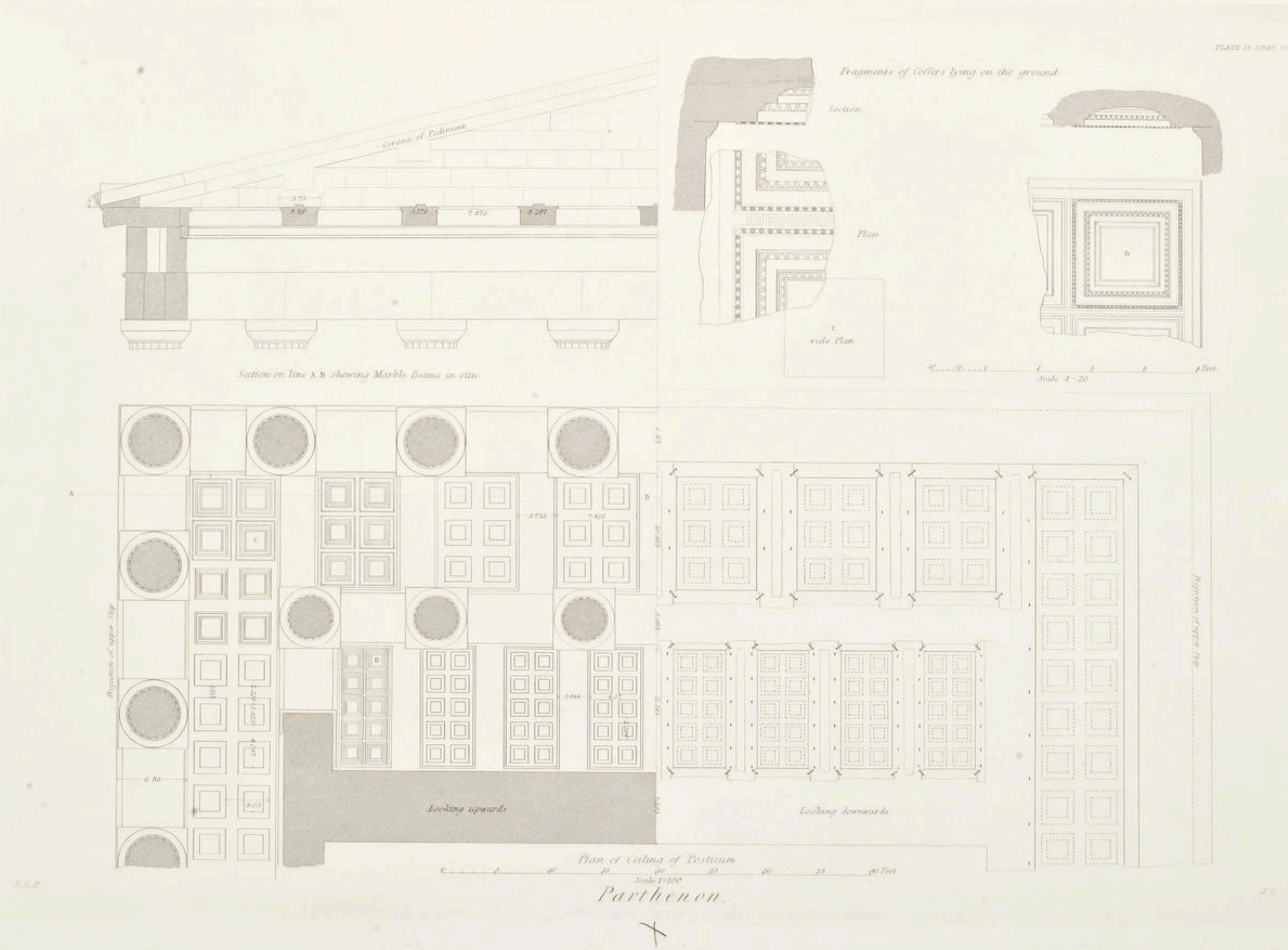


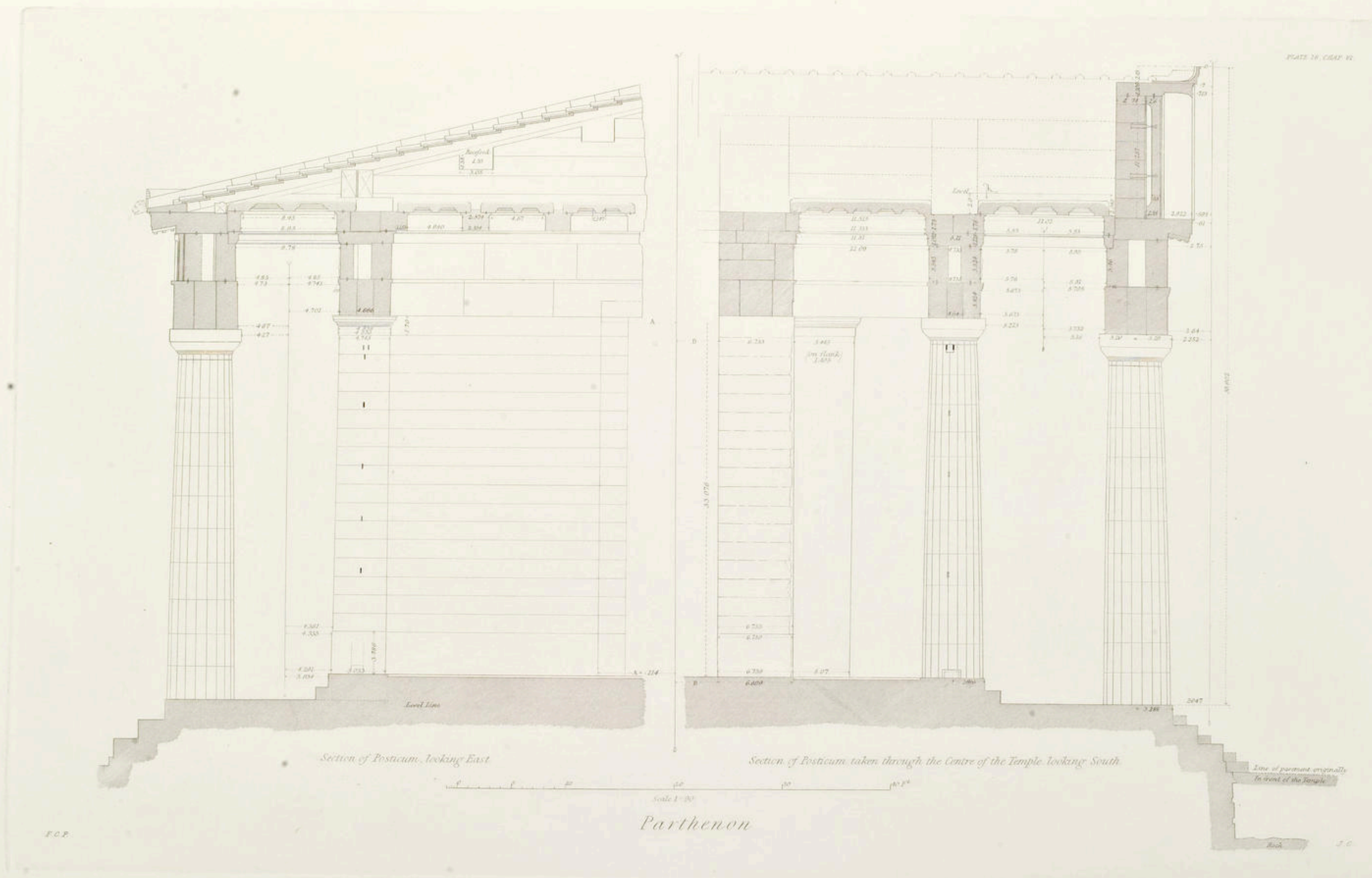
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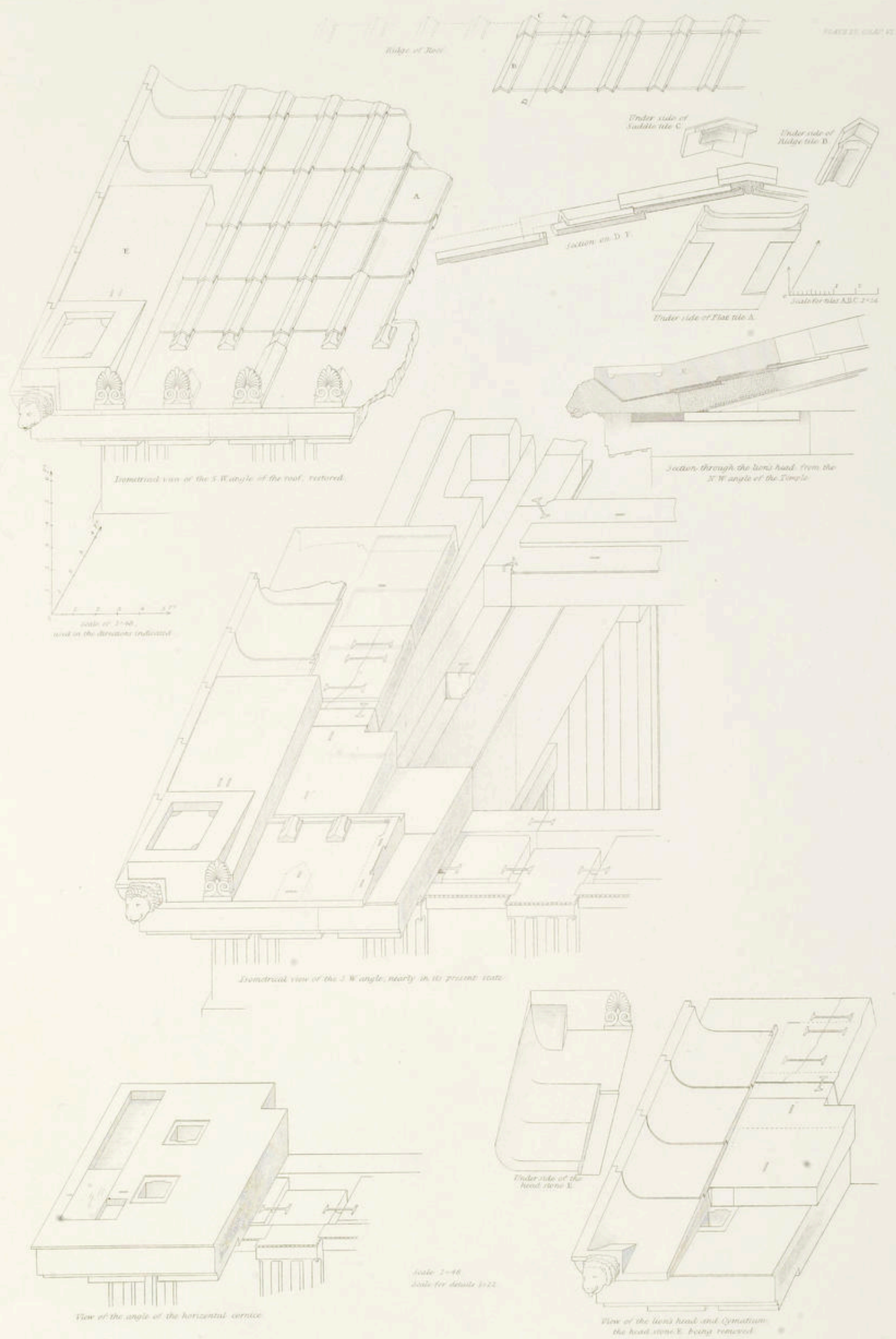
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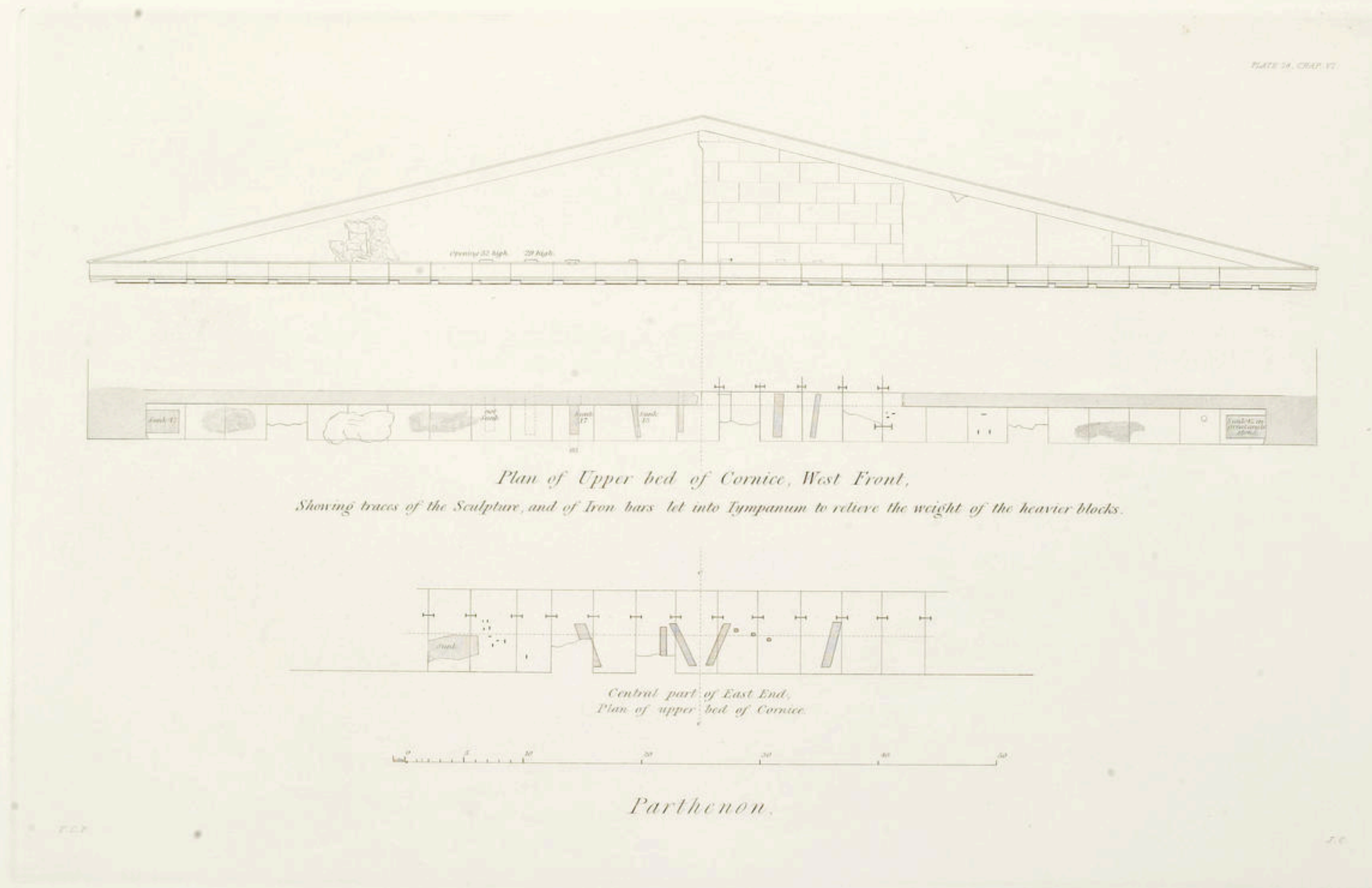








Various Isometrical Views showing the construction of the Roof at the S.W. angle of the Temple, Parthenon.



Sections of Mouldings $\frac{1}{3}$ full size.

Reference.

Thesum Fig. 6 & 29-32-30.

Parthenon Fig. 1, 2, 3 & 24-26-32.

Propylaea Fig. 4, 5 & 26-28-33.

Erechtheum Fig. 13.



Table to Fig. 10.

X ^o	Measured Offset	Offset from corresponding Hypocycle
0	0.000	0.000
1	0.003	0.003
2	0.007	0.007
3	0.012	0.012
4	0.017	0.017
5	0.023	0.023
6	0.029	0.029
7	0.036	0.036
8	0.043	0.043
9	0.051	0.051
10	0.059	0.059
11	0.067	0.067
12	0.076	0.076
13	0.085	0.085
14	0.094	0.094
15	0.104	0.104
16	0.114	0.114
17	0.124	0.124
18	0.135	0.135
19	0.146	0.146
20	0.157	0.157
21	0.169	0.169
22	0.181	0.181
23	0.193	0.193
24	0.206	0.206
25	0.219	0.219
26	0.232	0.232
27	0.246	0.246
28	0.260	0.260
29	0.274	0.274
30	0.289	0.289
31	0.304	0.304
32	0.319	0.319
33	0.334	0.334
34	0.349	0.349
35	0.365	0.365
36	0.381	0.381
37	0.397	0.397
38	0.413	0.413
39	0.430	0.430
40	0.447	0.447
41	0.464	0.464
42	0.482	0.482
43	0.500	0.500
44	0.518	0.518
45	0.536	0.536
46	0.555	0.555
47	0.574	0.574
48	0.593	0.593
49	0.613	0.613
50	0.633	0.633
51	0.653	0.653
52	0.673	0.673
53	0.694	0.694
54	0.714	0.714
55	0.735	0.735
56	0.756	0.756
57	0.777	0.777
58	0.798	0.798
59	0.819	0.819
60	0.840	0.840
61	0.862	0.862
62	0.884	0.884
63	0.906	0.906
64	0.928	0.928
65	0.950	0.950
66	0.973	0.973
67	0.996	0.996
68	1.019	1.019
69	1.042	1.042
70	1.065	1.065
71	1.088	1.088
72	1.111	1.111
73	1.134	1.134
74	1.157	1.157
75	1.180	1.180
76	1.203	1.203
77	1.226	1.226
78	1.249	1.249
79	1.272	1.272
80	1.295	1.295
81	1.318	1.318
82	1.341	1.341
83	1.364	1.364
84	1.387	1.387
85	1.410	1.410
86	1.433	1.433
87	1.456	1.456
88	1.479	1.479
89	1.502	1.502
90	1.525	1.525
91	1.548	1.548
92	1.571	1.571
93	1.594	1.594
94	1.617	1.617
95	1.640	1.640
96	1.663	1.663
97	1.686	1.686
98	1.709	1.709
99	1.732	1.732
100	1.755	1.755

Table to Fig. 4.

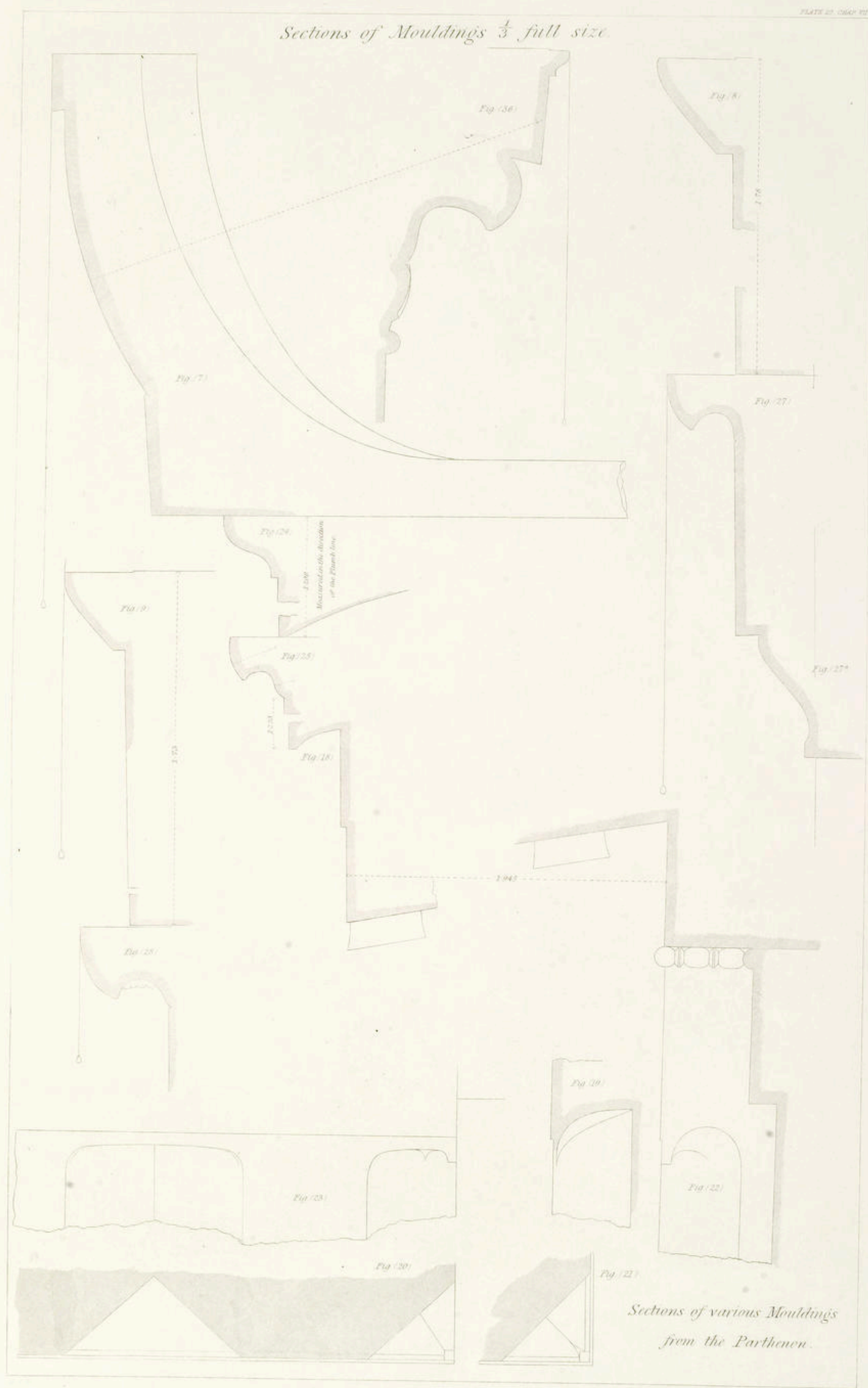
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12	0.076	0.076
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14	0.094	0.094
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35	0.365	0.365
36	0.381	0.381
37	0.397	0.397
38	0.413	0.413
39	0.430	0.430
40	0.447	0.447
41	0.464	0.464
42	0.482	0.482
43	0.500	0.500
44	0.518	0.518
45	0.536	0.536
46	0.555	0.555
47	0.574	0.574
48	0.593	0.593
49	0.613	0.613
50	0.633	0.633
51	0.653	0.653
52	0.673	0.673
53	0.694	0.694
54	0.714	0.714
55	0.735	0.735
56	0.756	0.756
57	0.777	0.777
58	0.798	0.798
59	0.819	0.819
60	0.840	0.840
61	0.862	0.862
62	0.884	0.884
63	0.906	0.906
64	0.928	0.928
65	0.950	0.950
66	0.973	0.973
67	0.996	0.996
68	1.019	1.019
69	1.042	1.042
70	1.065	1.065
71	1.088	1.088
72	1.111	1.111
73	1.134	1.134
74	1.157	1.157
75	1.180	1.180
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83	1.364	1.364
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88	1.479	1.479
89	1.502	1.502
90	1.525	1.525
91	1.548	1.548
92	1.571	1.571
93	1.594	1.594
94	1.617	1.617
95	1.640	1.640
96	1.663	1.663
97	1.686	1.686
98	1.709	1.709
99	1.732	1.732
100	1.755	1.755

Table to Fig. 5.

X ^o	Measured Offset	Offset from corresponding Hypocycle
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2	0.007	0.007
3	0.012	0.012
4	0.017	0.017
5	0.023	0.023
6	0.029	0.029
7	0.036	0.036
8	0.043	0.043
9	0.051	0.051
10	0.059	0.059
11	0.067	0.067
12	0.076	0.076
13	0.085	0.085
14	0.094	0.094
15	0.104	0.104
16	0.114	0.114
17	0.124	0.124
18	0.135	0.135
19	0.146	0.146
20	0.157	0.157
21	0.169	0.169
22	0.181	0.181
23	0.193	0.193
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25	0.219	0.219
26	0.232	0.232
27	0.246	0.246
28	0.260	0.260
29	0.274	0.274
30	0.289	0.289
31	0.304	0.304
32	0.319	0.319
33	0.334	0.334
34	0.349	0.349
35	0.365	0.365
36	0.381	0.381
37	0.397	0.397
38	0.413	0.413
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46	0.555	0.555
47	0.574	0.574
48	0.593	0.593
49	0.613	0.613
50	0.633	0.633
51	0.653	0.653
52	0.673	0.673
53	0.694	0.694
54	0.714	0.714
55	0.735	0.735
56	0.756	0.756
57	0.777	0.777
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60	0.840	0.840
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65	0.950	0.950
66	0.973	0.973
67	0.996	0.996
68	1.019	1.019
69	1.042	1.042
70	1.065	1.065
71	1.088	1.088
72	1.111	1.111
73	1.134	1.134
74	1.157	1.157
75	1.180	1.180
76	1.203	1.203
77	1.226	1.226
78	1.249	1.249
79	1.272	1.272
80	1.295	1.295
81	1.318	1.318
82	1.341	1.341
83	1.364	1.364
84	1.387	1.387
85	1.410	1.410
86	1.433	1.433
87	1.456	1.456
88	1.479	1.479
89	1.502	1.502
90	1.525	1.525
91	1.548	1.548
92	1.571	1.571
93	1.594	1.594
94	1.617	1.617
95	1.640	1.640
96	1.663	1.663
97	1.686	1.686
98	1.709	1.709
99	1.732	1.732
100	1.755	1.755

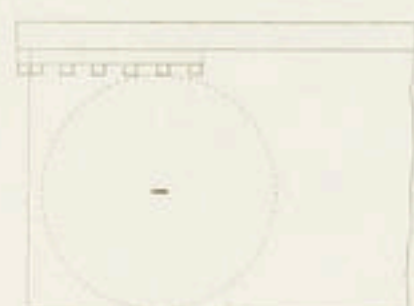
Table to Fig. 11.

X ^o	Measured Offset	Offset from corresponding Hypocycle
0	0.000	0.000
1	0.003	0.003
2	0.007	0.007
3	0.012	0.012
4	0.017	0.017
5	0.023	0.023
6	0.029	0.029
7	0.036	0.036
8	0.043	0.043
9	0.051	0.051
10	0.059	0.059
11	0.067	0.067
12	0.076	0.076
13	0.085	0.085
14	0.094	0.094
15	0.104	0.104
16	0.114	0.114
17	0.124	0.124
18	0.135	0.135
19	0.146	0.146
20	0.157	0.157
21	0.169	0.169
22	0.181	0.181
23	0.193	0.193
24	0.206	0.206
25	0.219	0.219
26	0.232	0.232
27	0.246	0.246
28	0.260	0.260
29	0.274	0.274
30	0.289	0.289
31	0.304	0.304
32	0.319	0.319
33	0.334	0.334
34	0.349	0.349
35	0.365	0.365
36	0.381	0.381
37	0.397	0.397
38	0.413	0.413
39	0.430	0.430
40	0.447	0.447
41	0.464	0.464
42	0.482	0.482
43	0.500	0.500
44	0.518	0.518
45	0.536	0.536
46	0.555	0.555
47	0.574	0.574
48	0.593	0.593
49	0.613	0.613
50	0.633	0.633
51	0.653	0.653
52	0.673	0.673
53	0.694	0.694
54	0.714	0.714
55	0.735	0.735



Sections of Mouldings $\frac{1}{3}$ full size.

Miscellaneous Details of the Parthenon.



W. Front X. angle.
Fastenings for a shield, similar to
that of the S. angle.

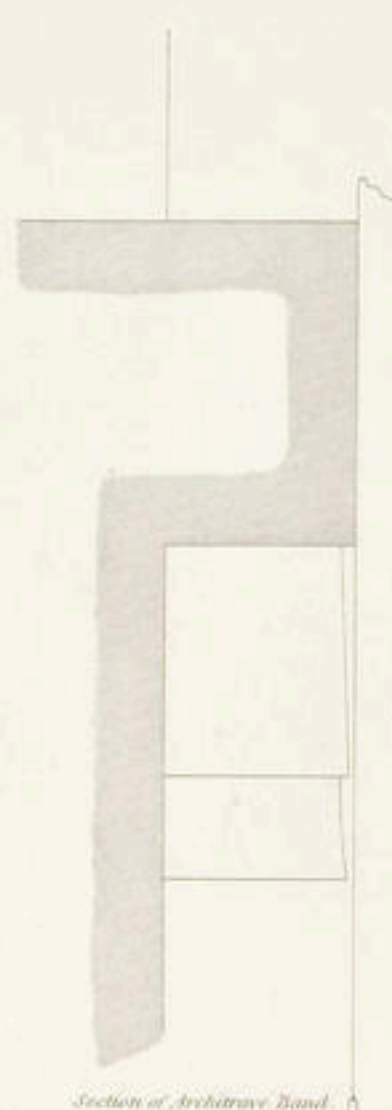


Architrave on the X. side, showing metal fastenings for garlands or other ornaments.

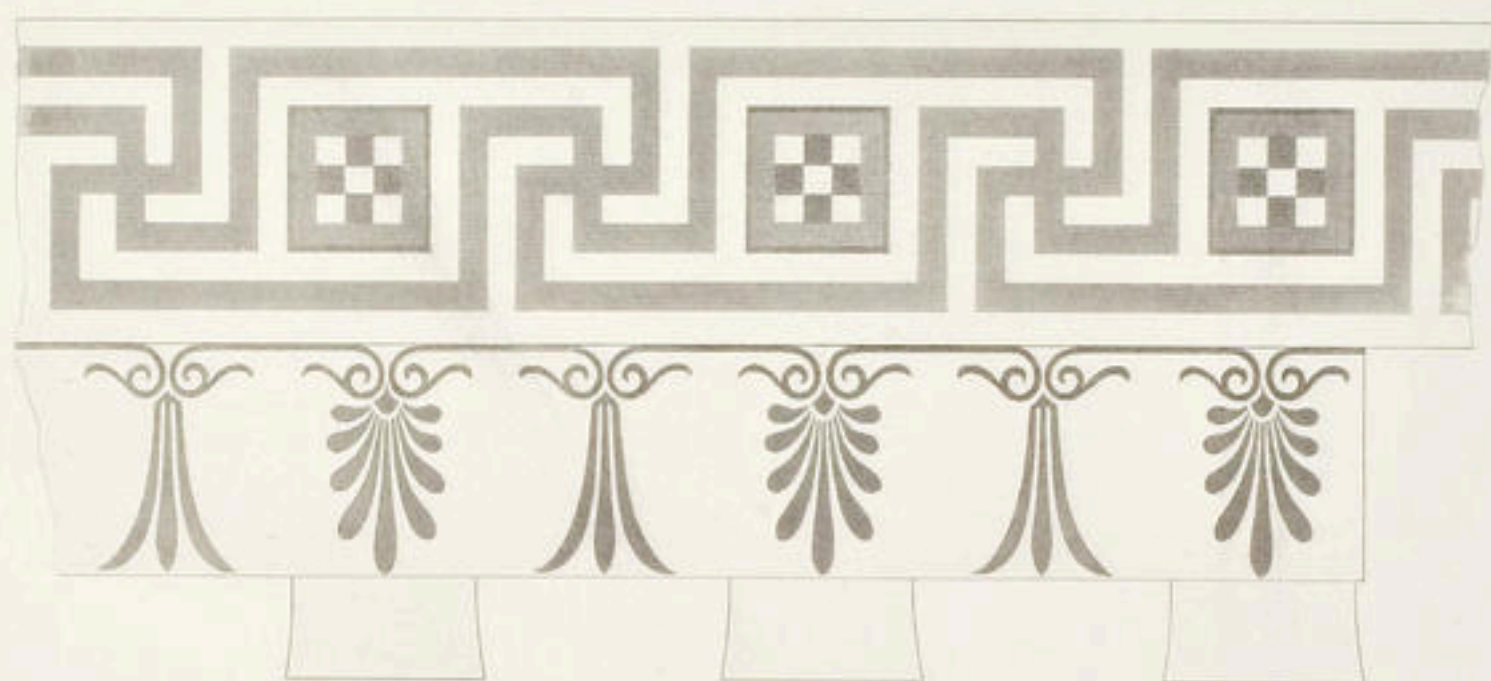


Trace of a shield on the S. angle of W. Front.
There are similar traces on the other of each angle.

Scale 1" = 40'

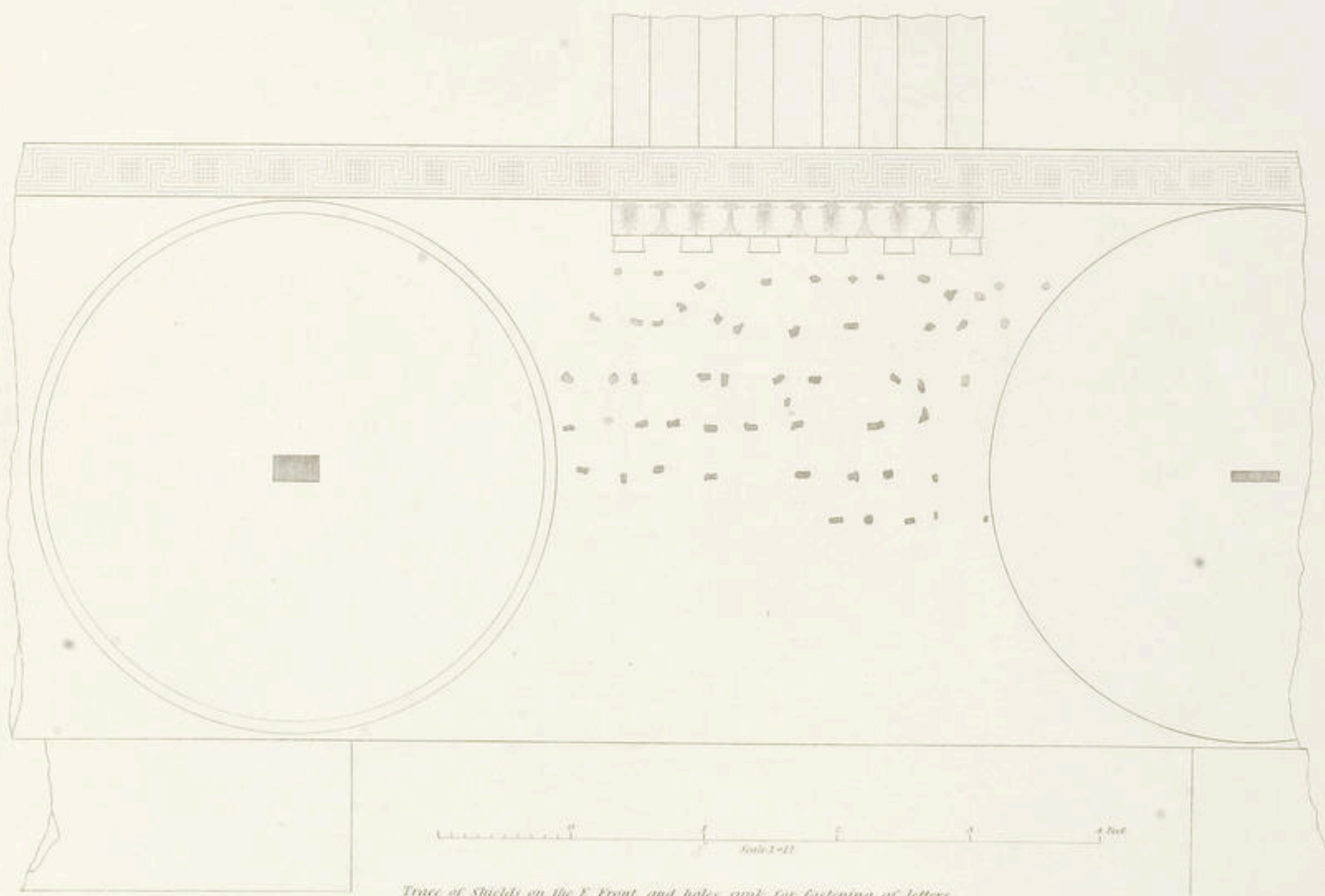


Section of Architrave Band.



Scale 1" = 3'

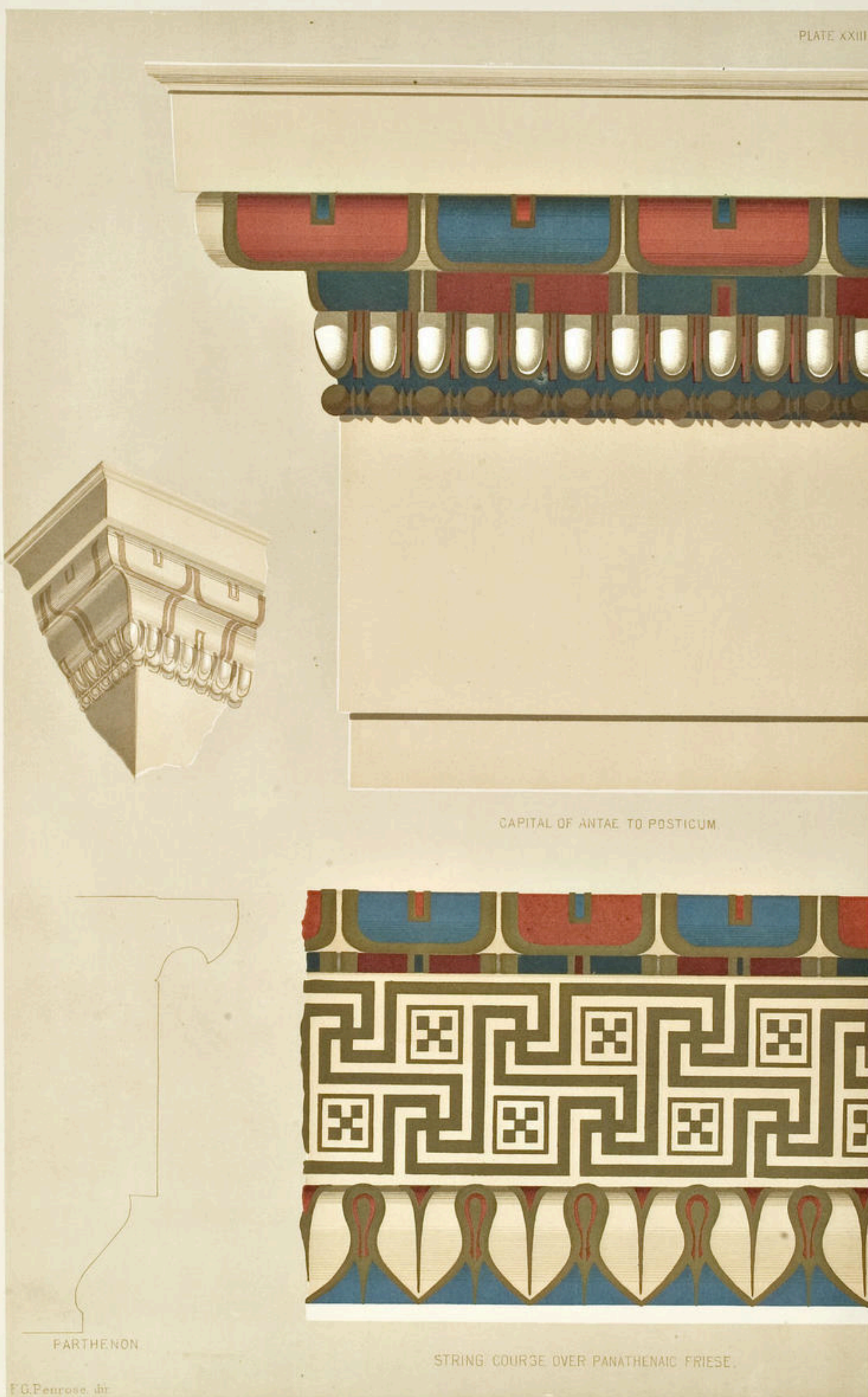
Frieze on Architrave band, and trace of painted ornaments over gutter.

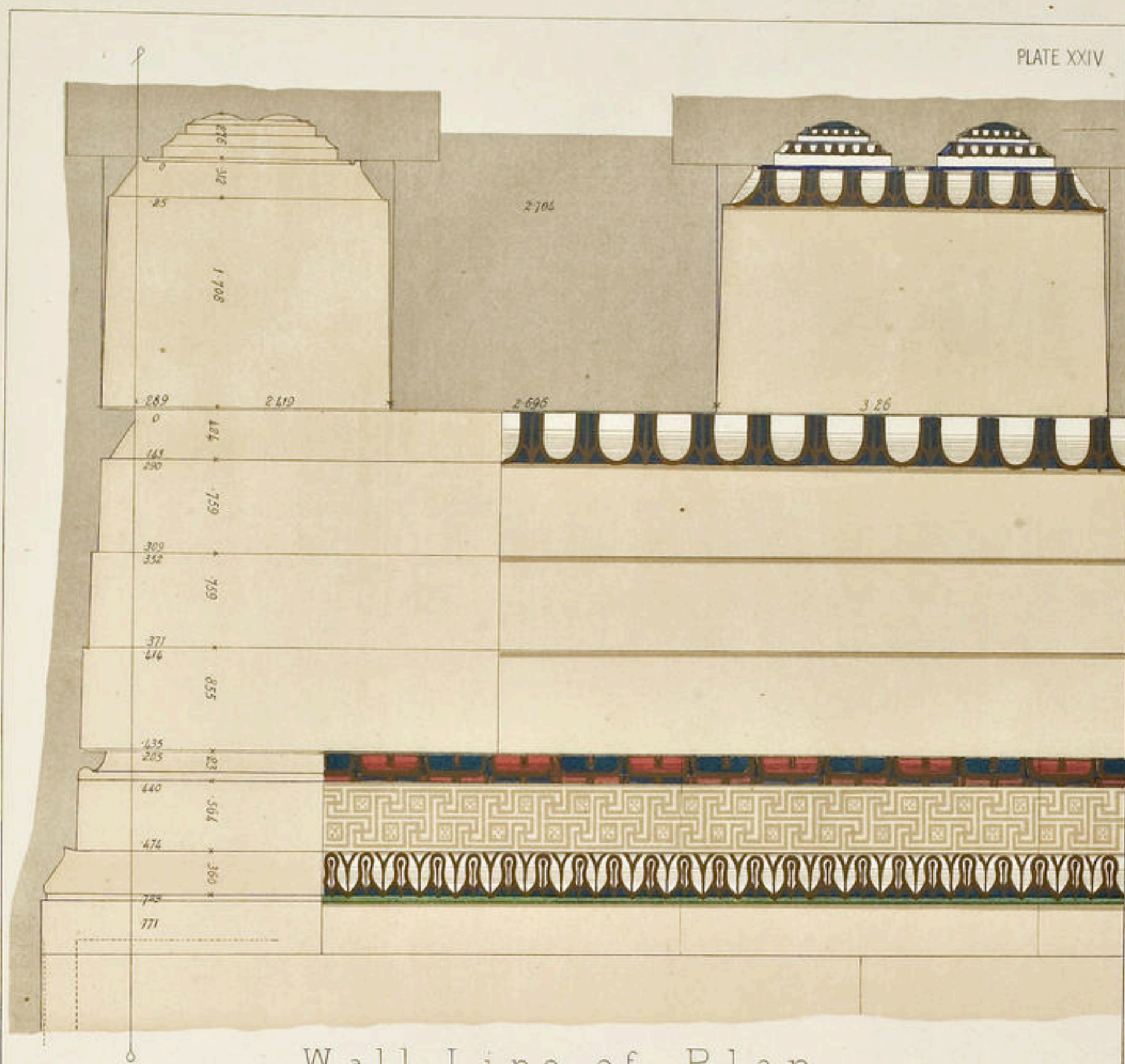


Trace of Shields on the E. Front, and holes sunk for fastening of letters.
The holes are generally 1/16" deep.

B. 127

B. 128





Wall Line of Plan



Ovolo of Architrave

Scale 1/13
T. Wilson, del.

PROPYLÆA ATHENS

ELEVATION AND SECTION SHEWING THE SMALL CORNICE, IONIC ARCHITRAVE, BEAMS, COFFERS &c IN THE INTERIOR OF THE W. PORTICO, ALSO PLAN OF THE SAME AND PROFILES $\frac{1}{2}$ REAL SIZE

Nº 1.



Nº 2.



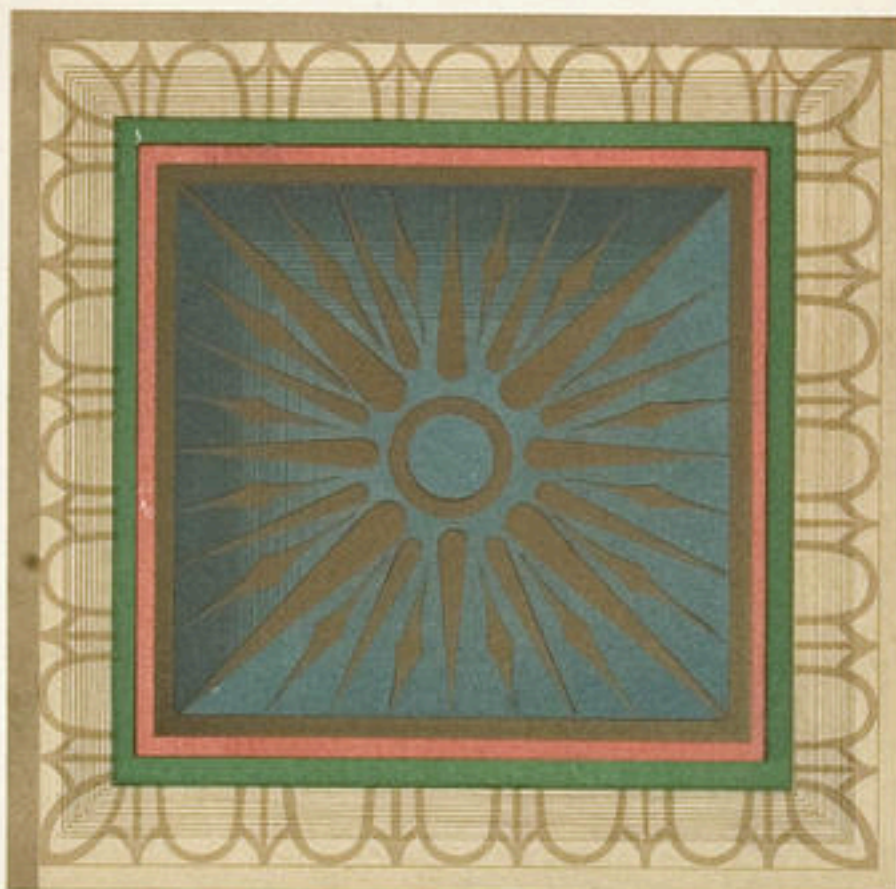
Nº 3.



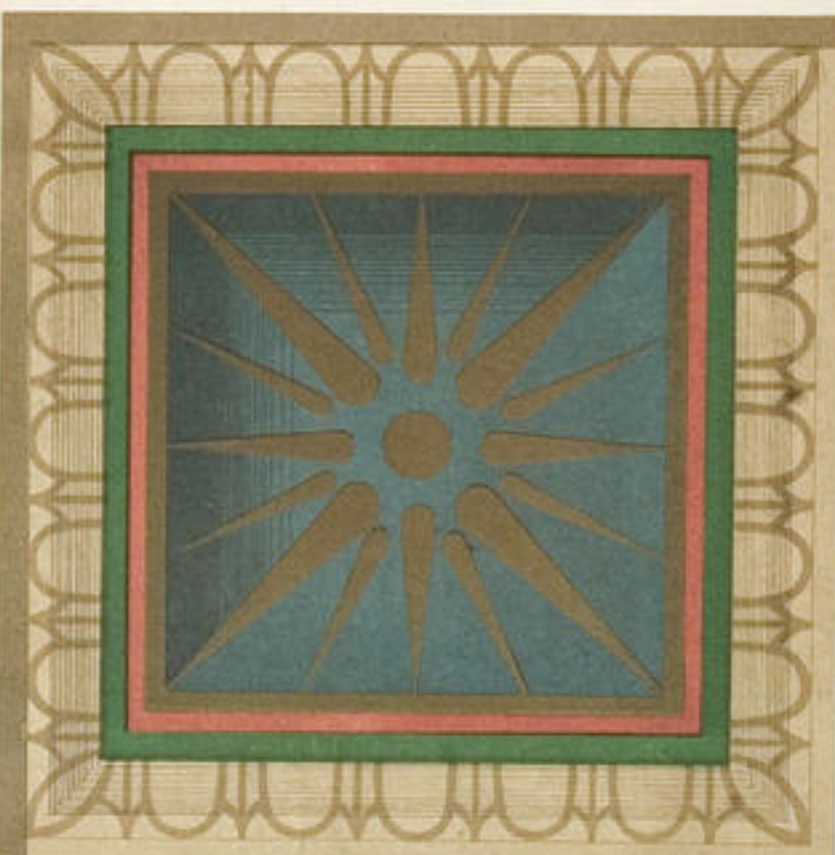
Nº 4.



Nº 5.

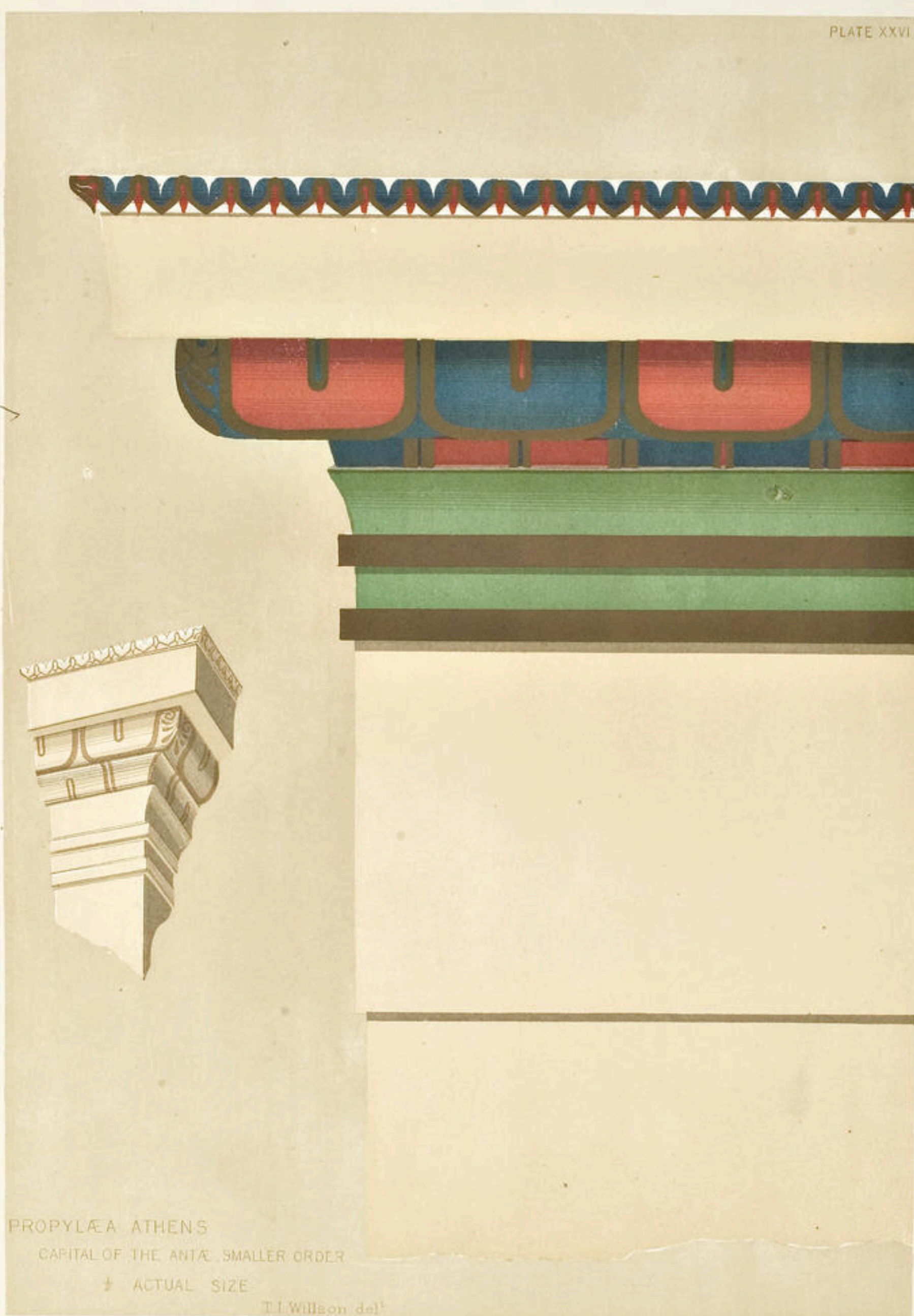


Nº 6.



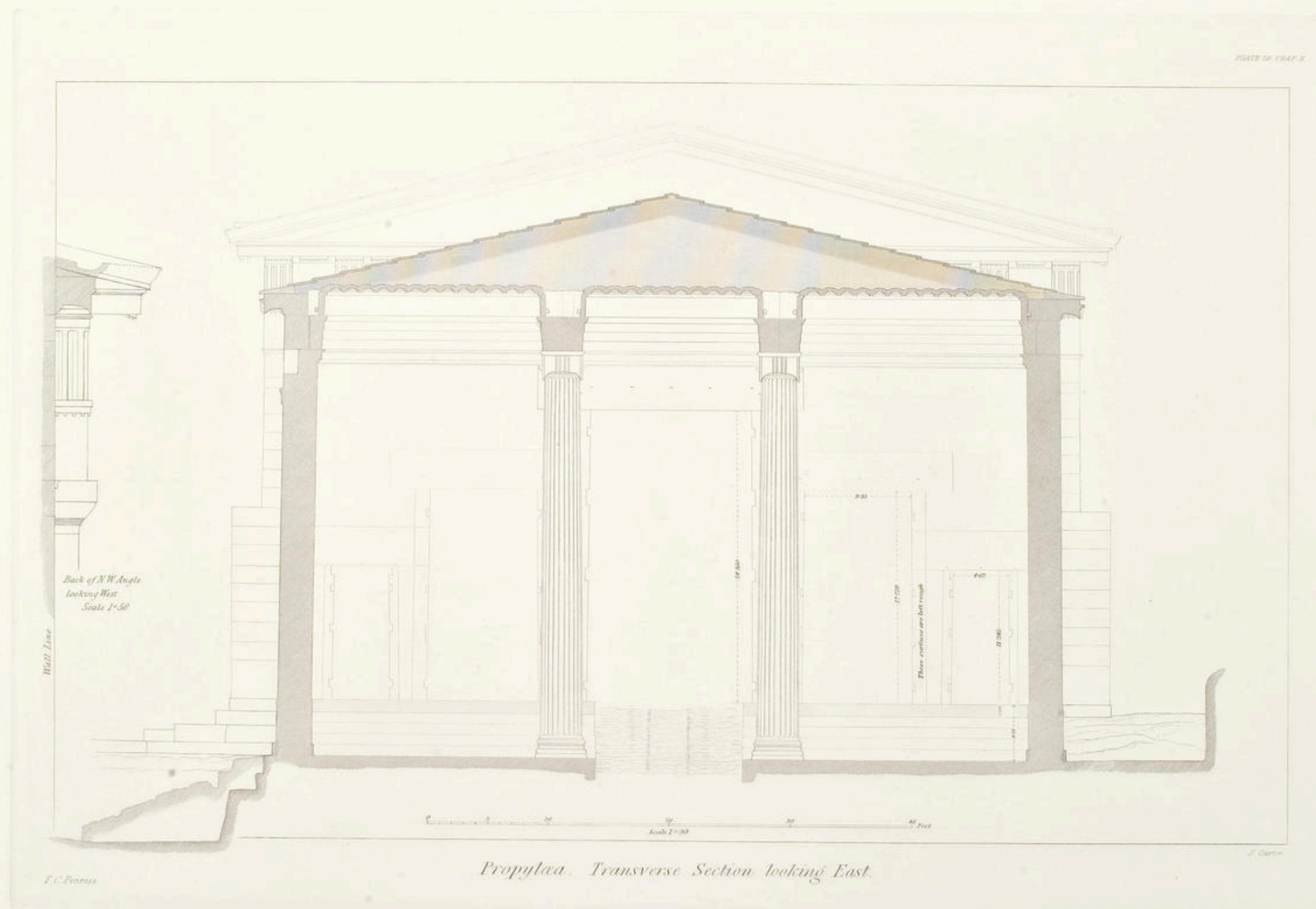
T. J. Wilson

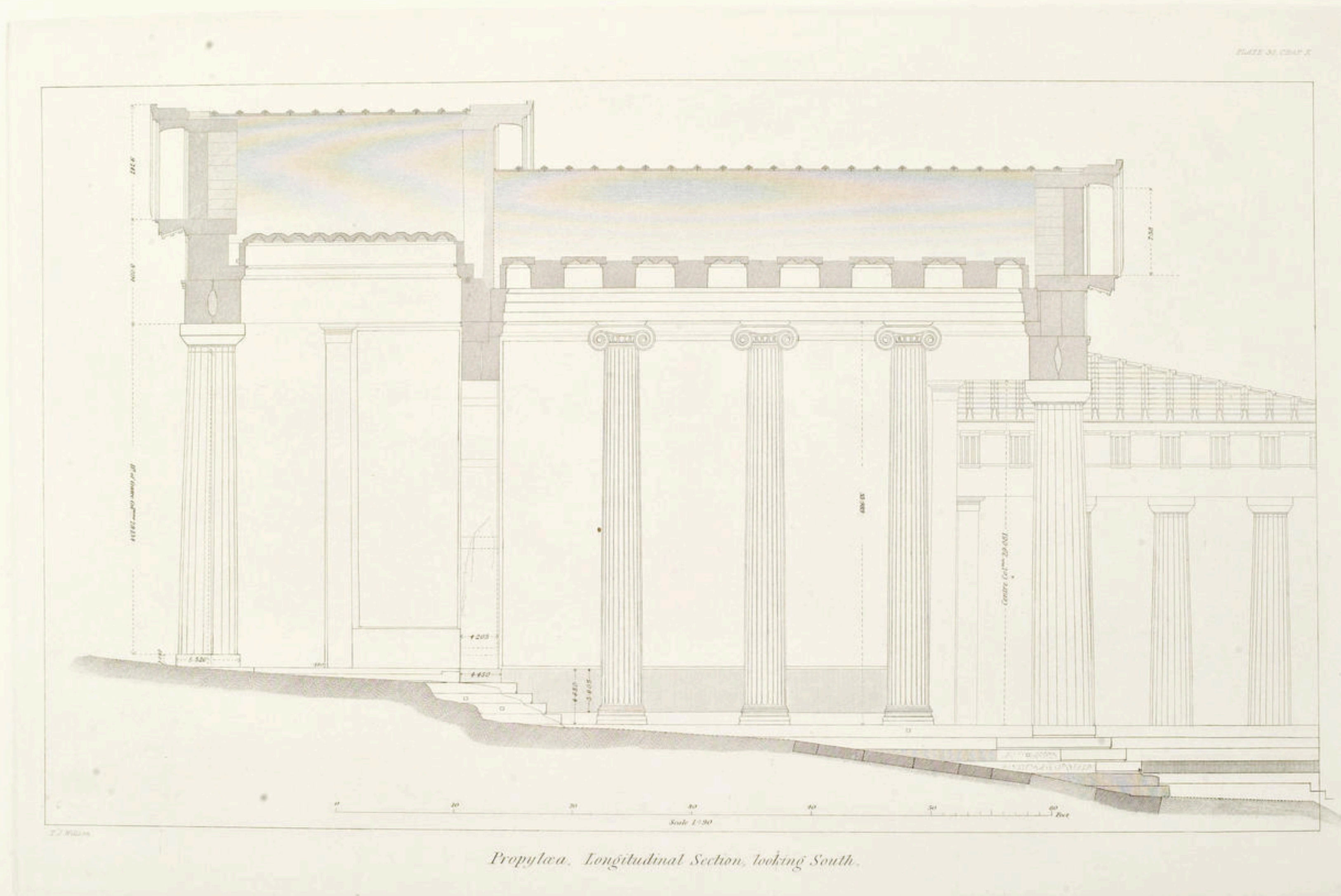
VARIOUS EXAMPLES OF THE PAINTED ORNAMENTS IN THE CENTRES OF THE COFFERS
OF THE CEILING OF THE PROPYLÆA ATHENS
HALF THE REAL SIZE.

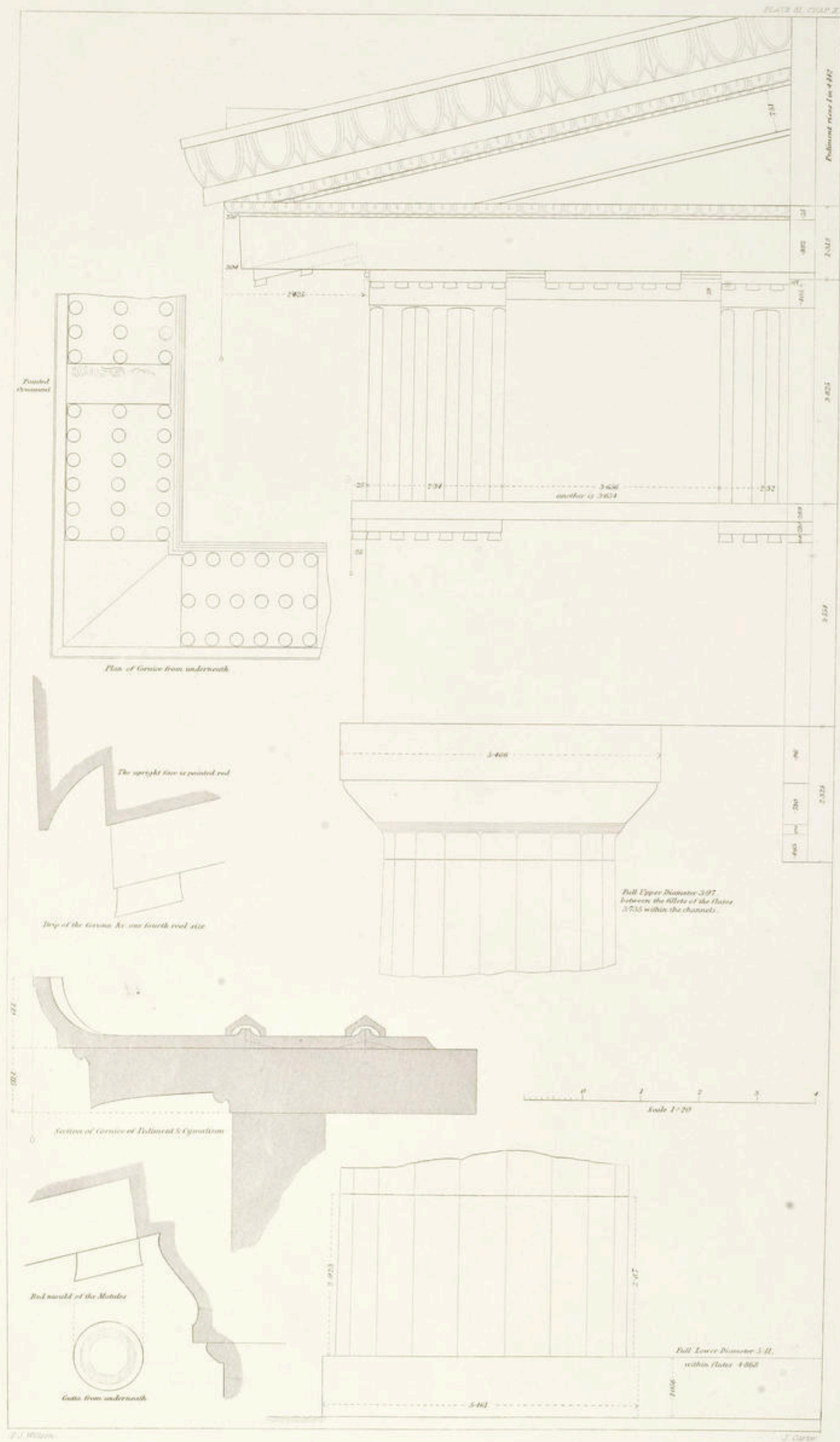




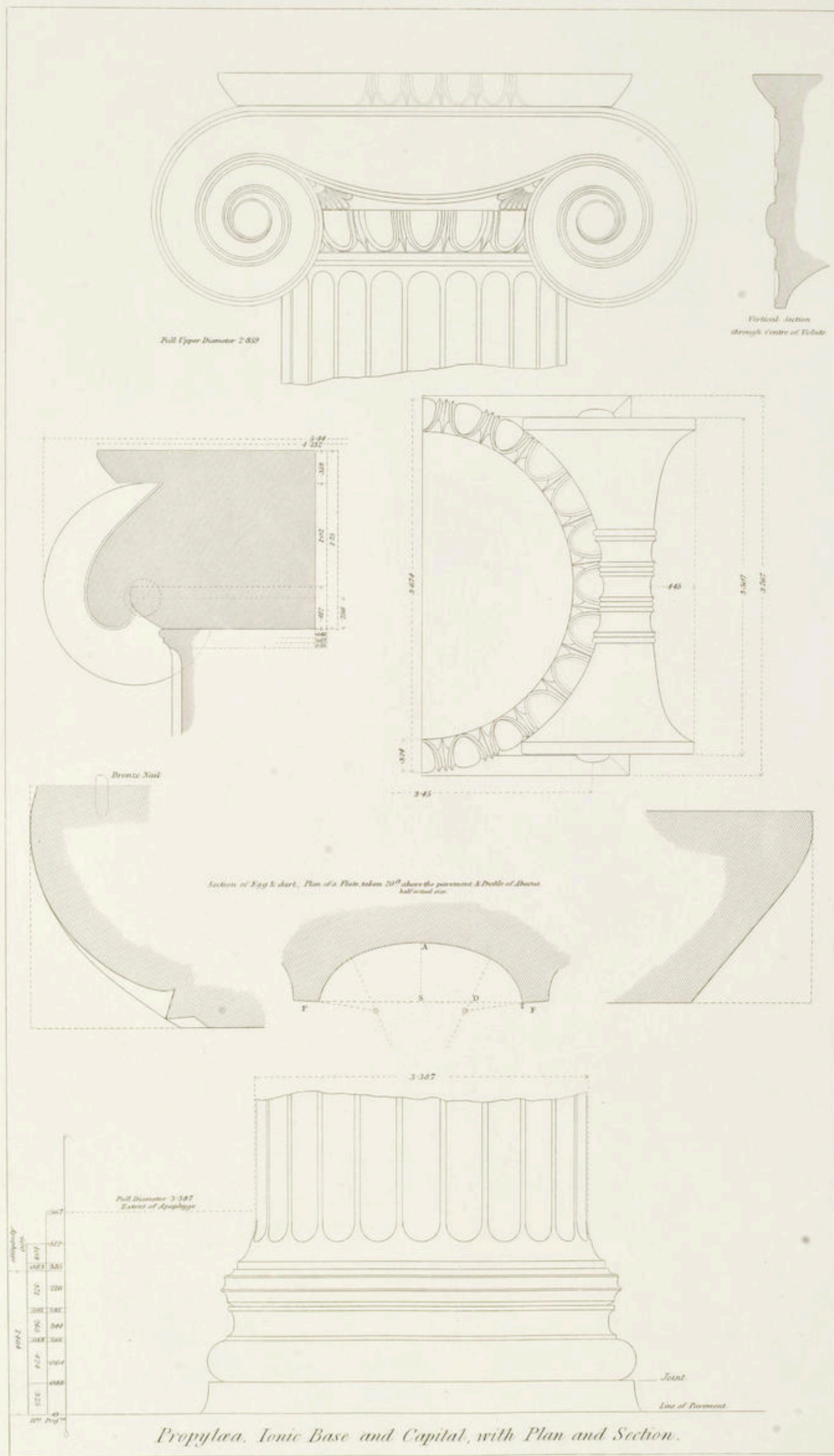
Restored Elevation of W. Front—Propylaea.







Propylaea, Angle Column & Entablature of Larger Order, East Front.

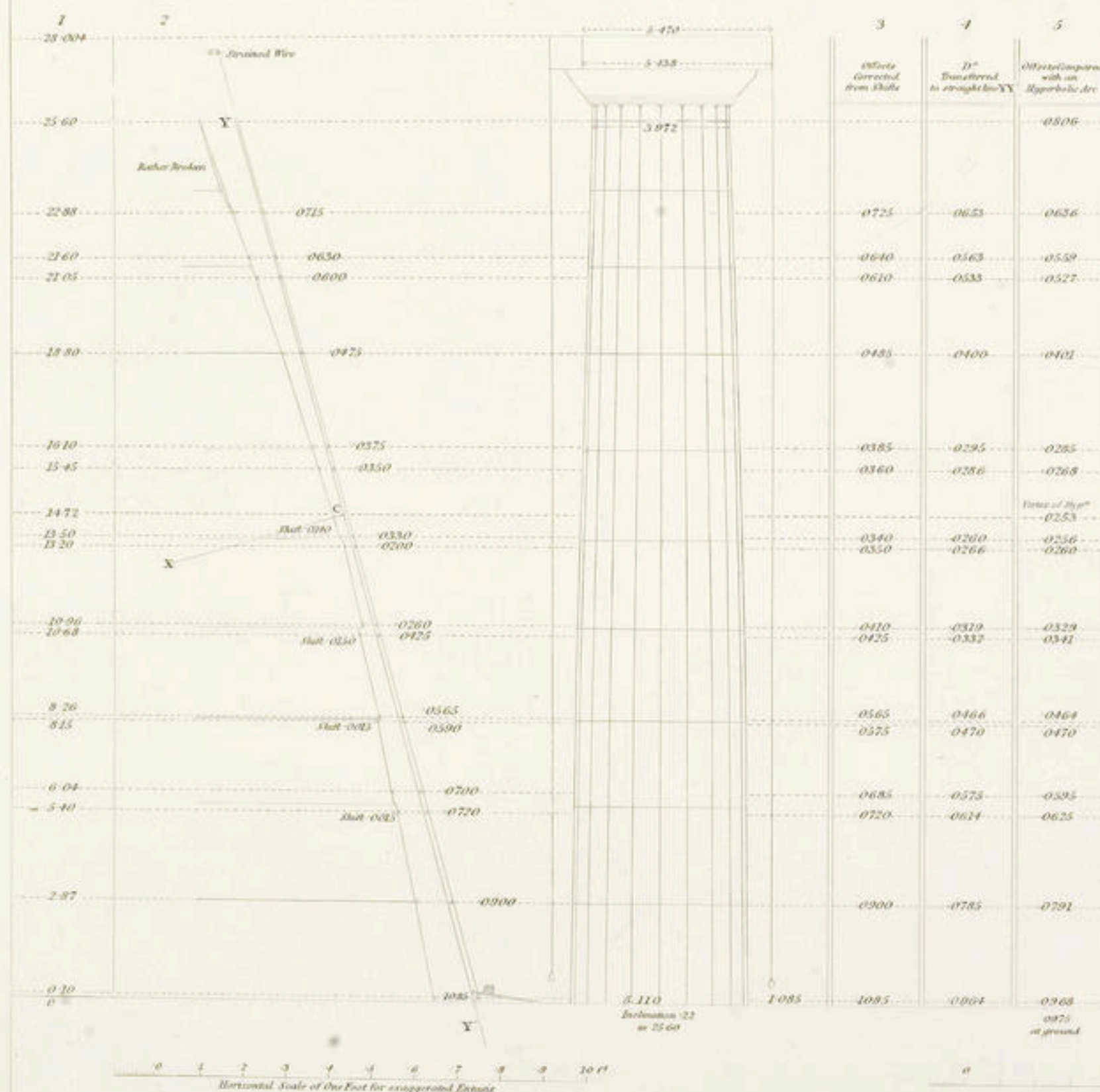


Scale 1"=12'

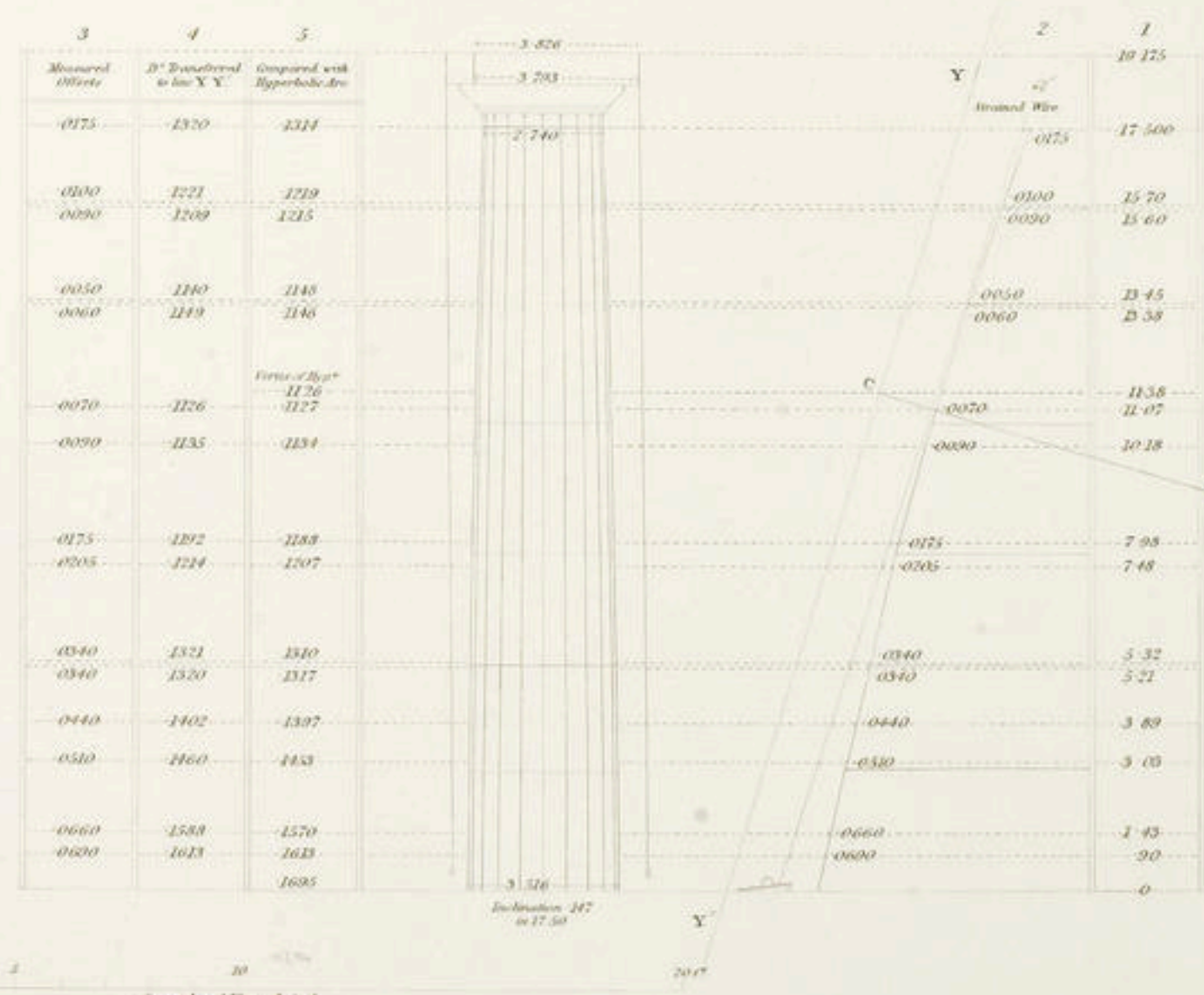
J. J. Wilton

J. J. Wilton

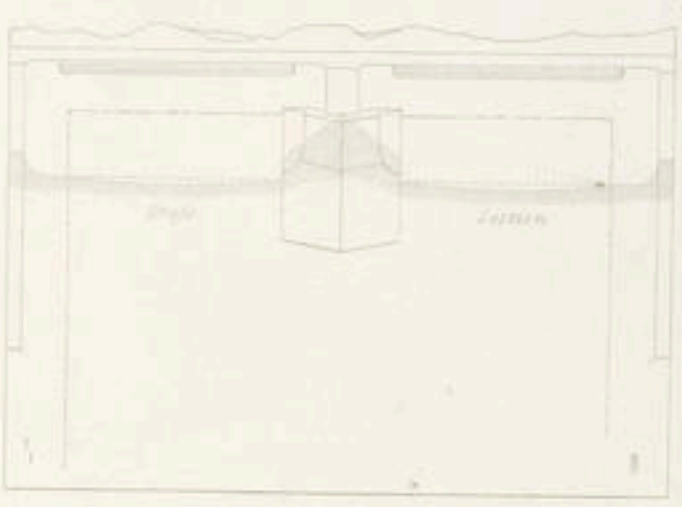
Propylaea.
Entasis from Northern Column, Eastern Portico.



Propylaea.
Small Order.
Entasis from Middle Column, North Wing.

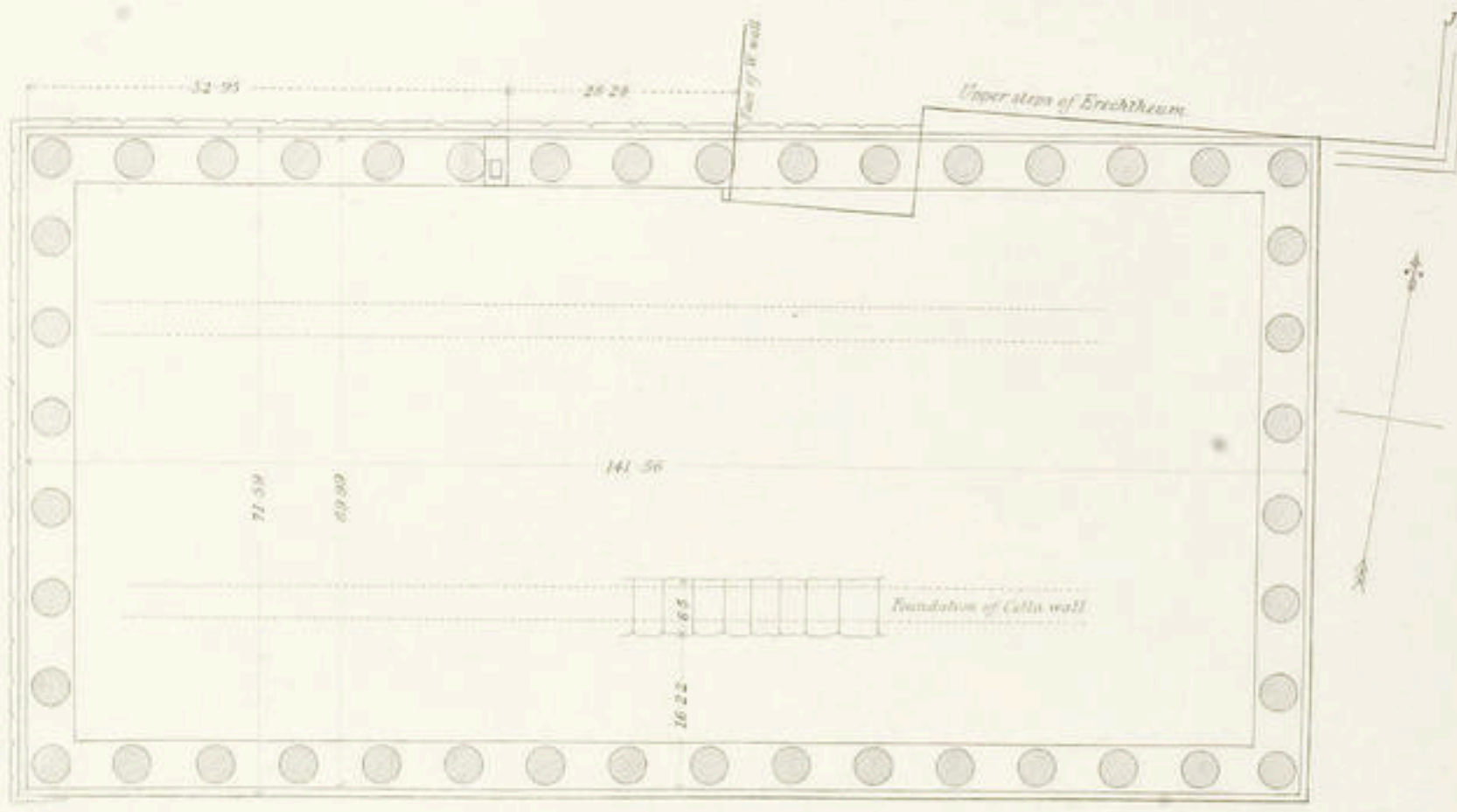
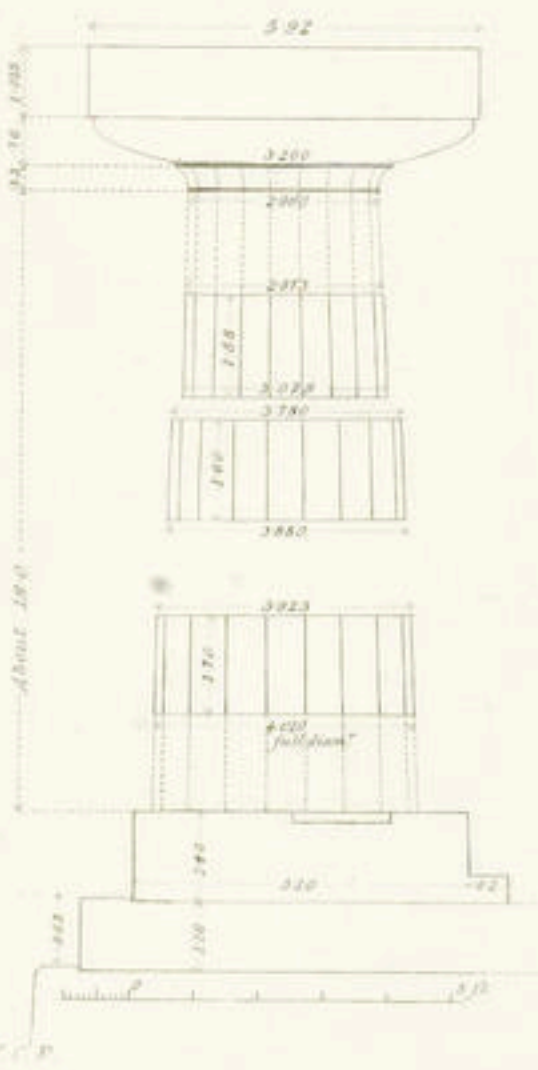


J. Carter



T.J.W.

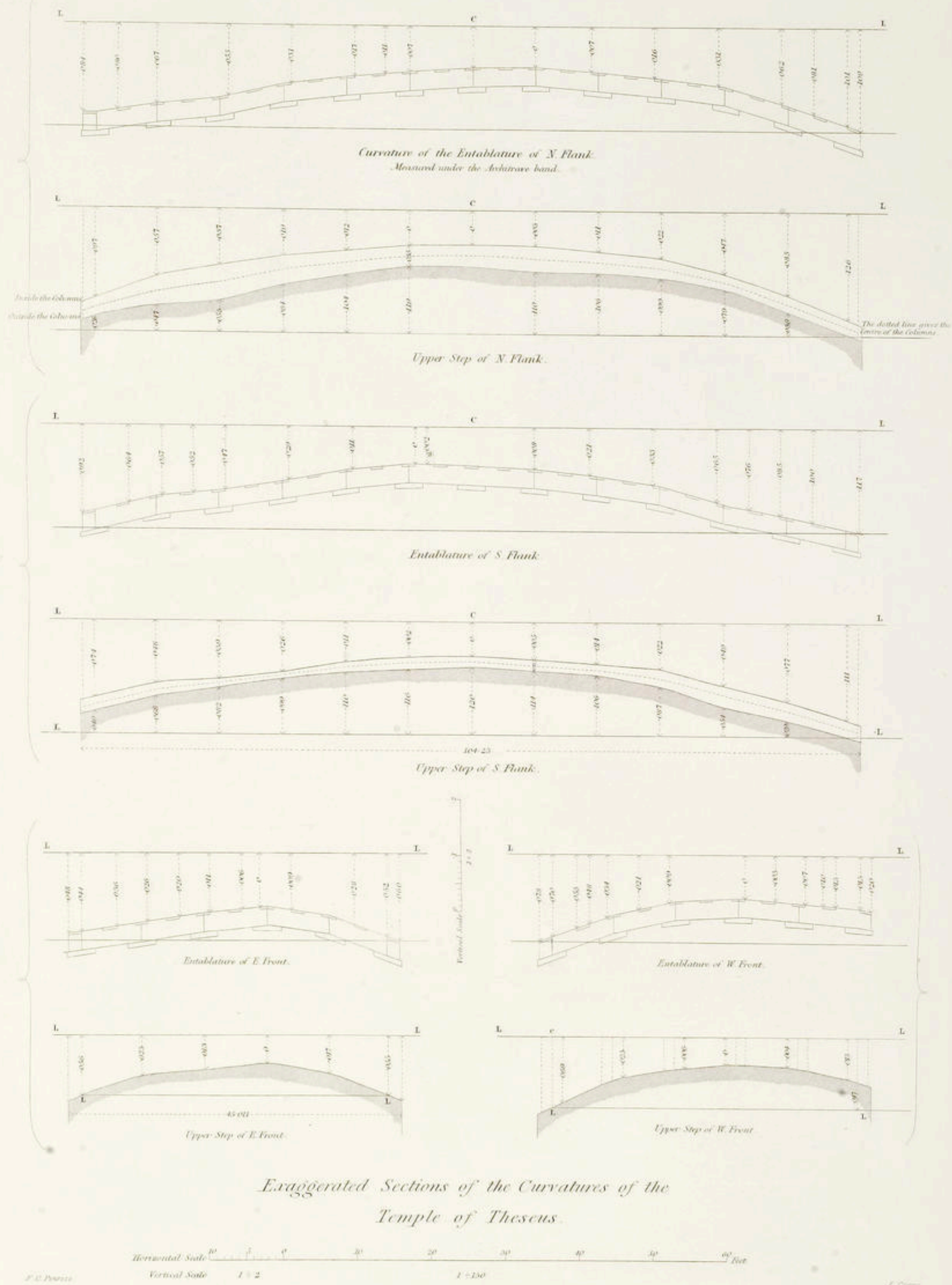
Details of the roofing of the Propylaea.



Plan of the ancient Temple (Cecropium?) S.W. of Erechtheum.

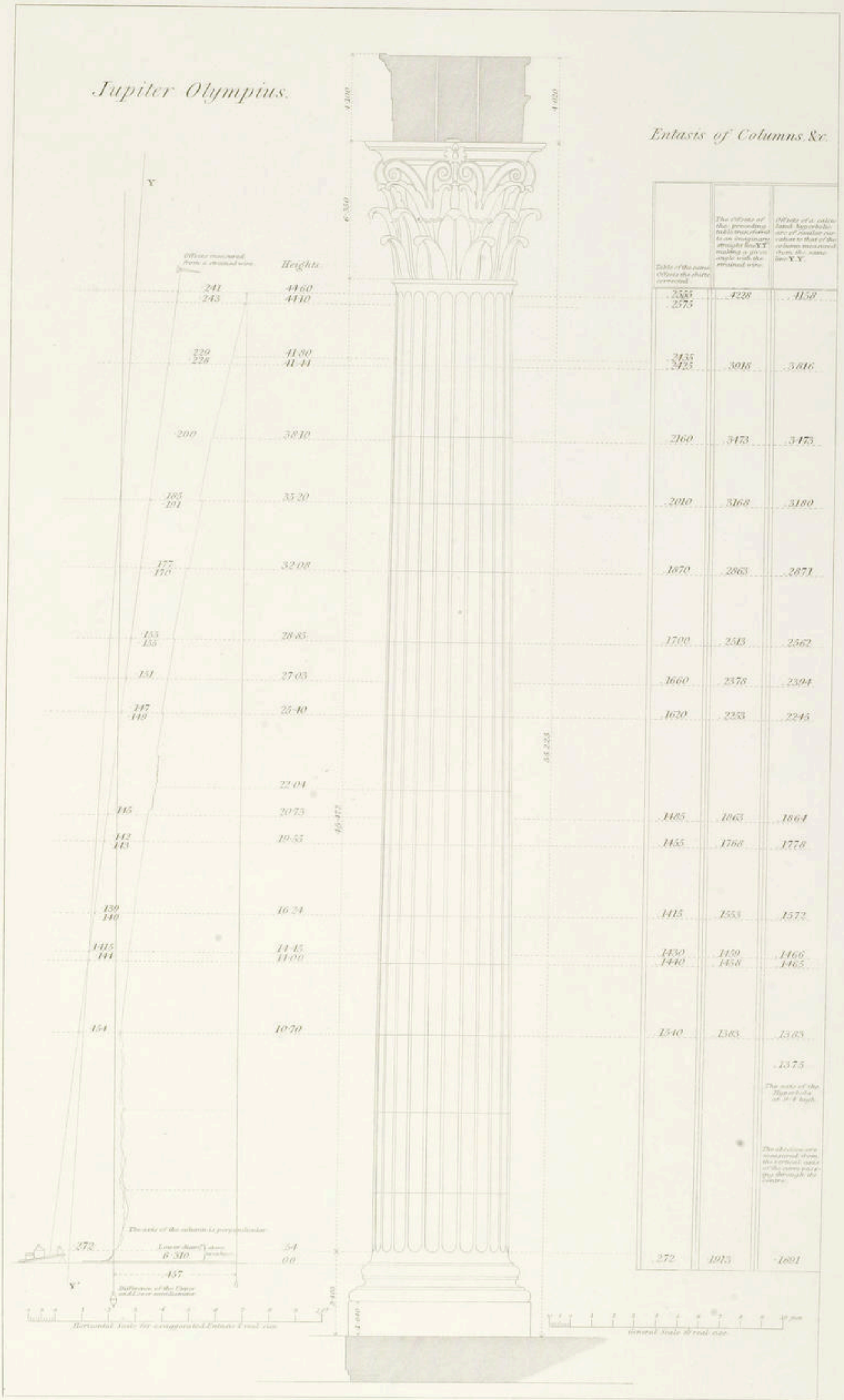
G.J.

Temple of Theseus



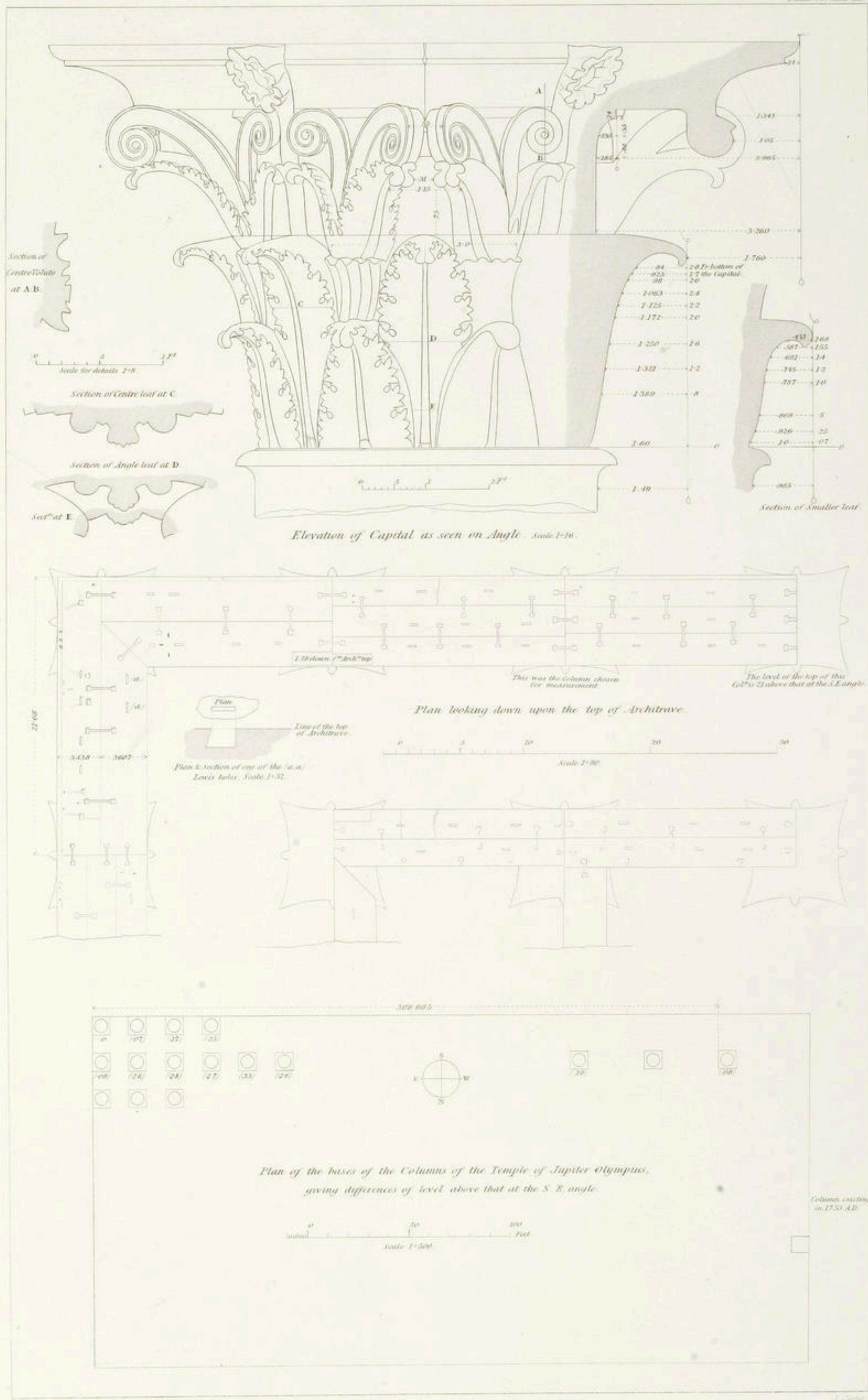
J. E. Penrose

J. Dims



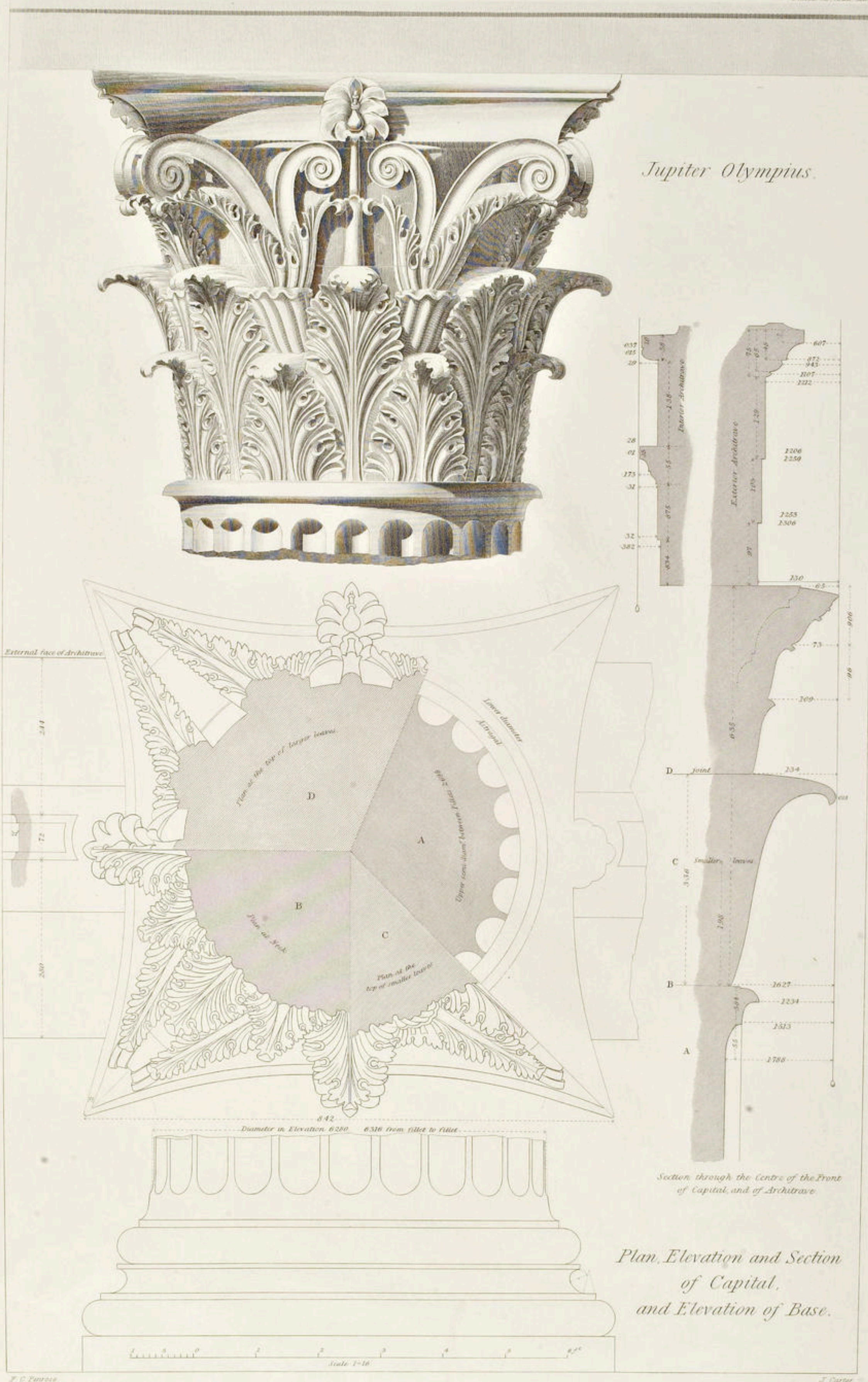
J. Penrose

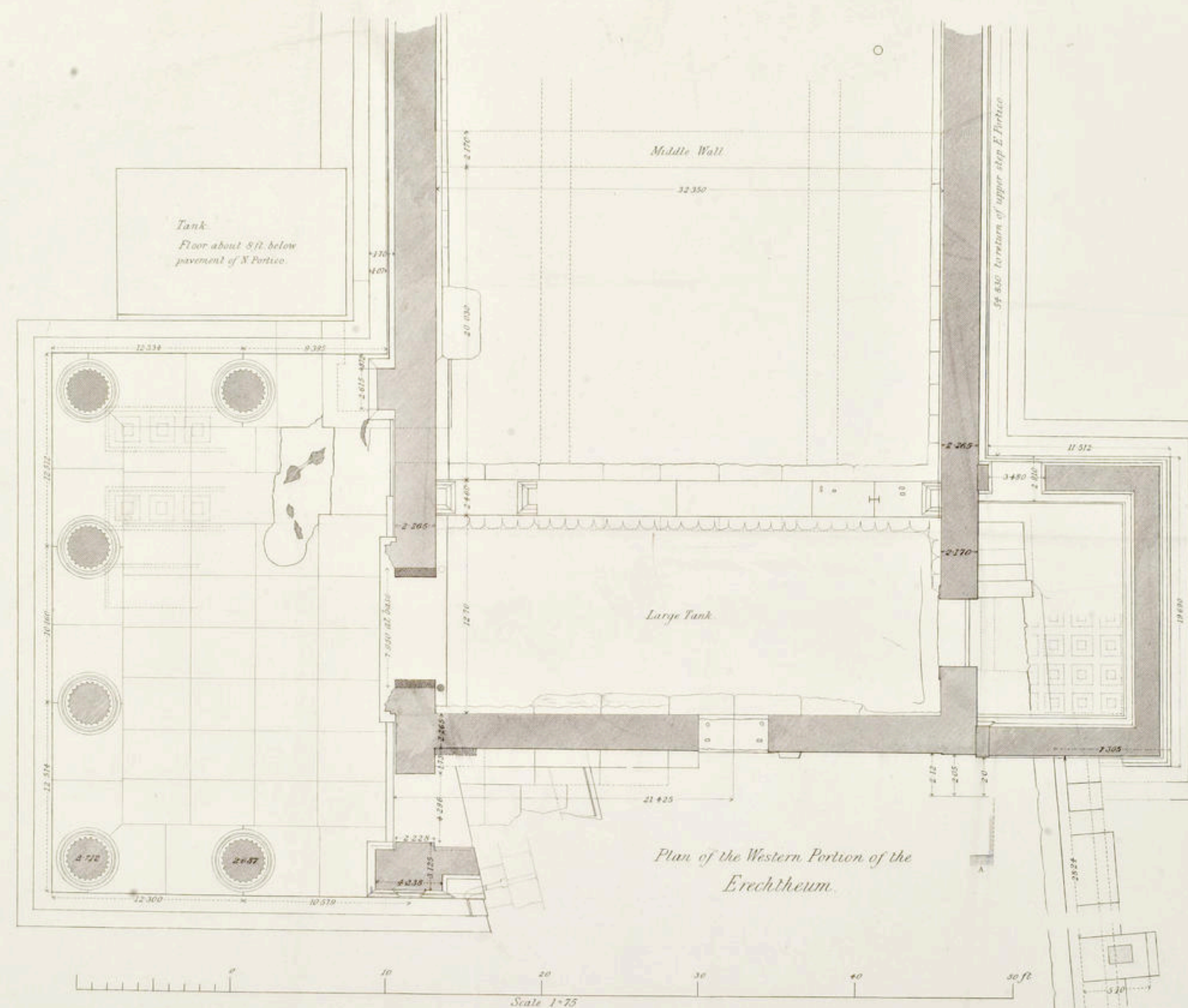
J. Cuvier



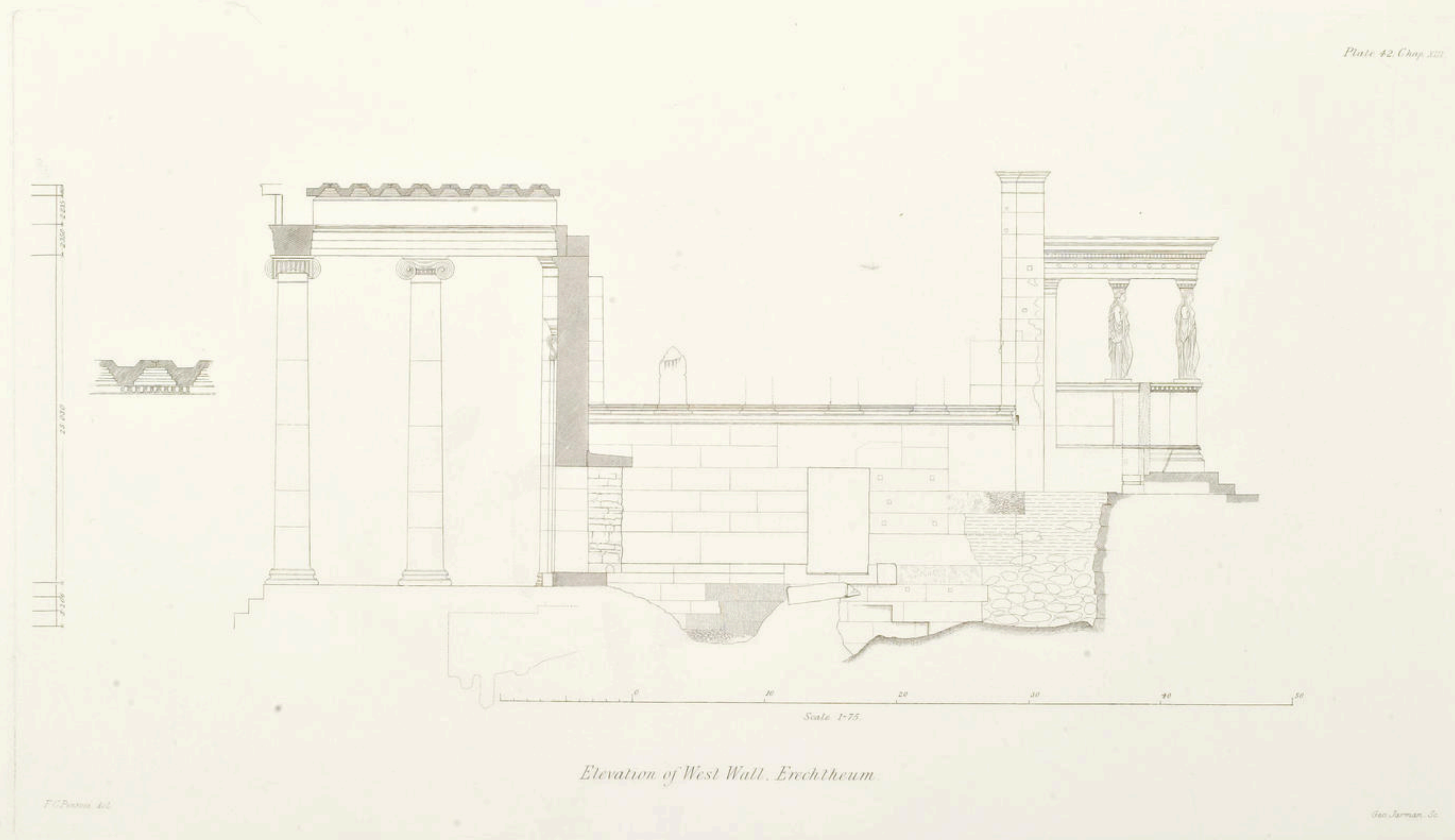
J.C. Smith

J.C. Smith





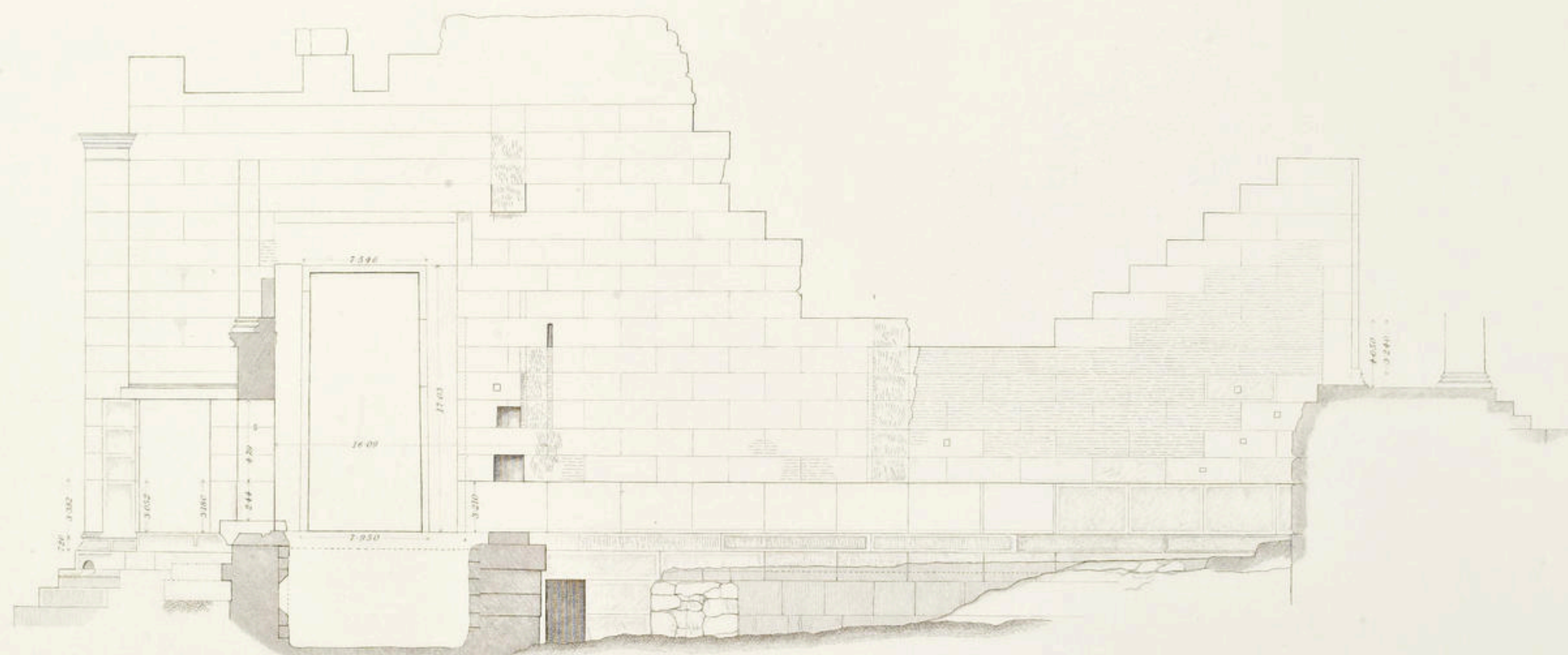
Geo. Farnham



Elevation of West Wall, Erechtheum.

Geo. Searman sc.

F. G. Penrose del.

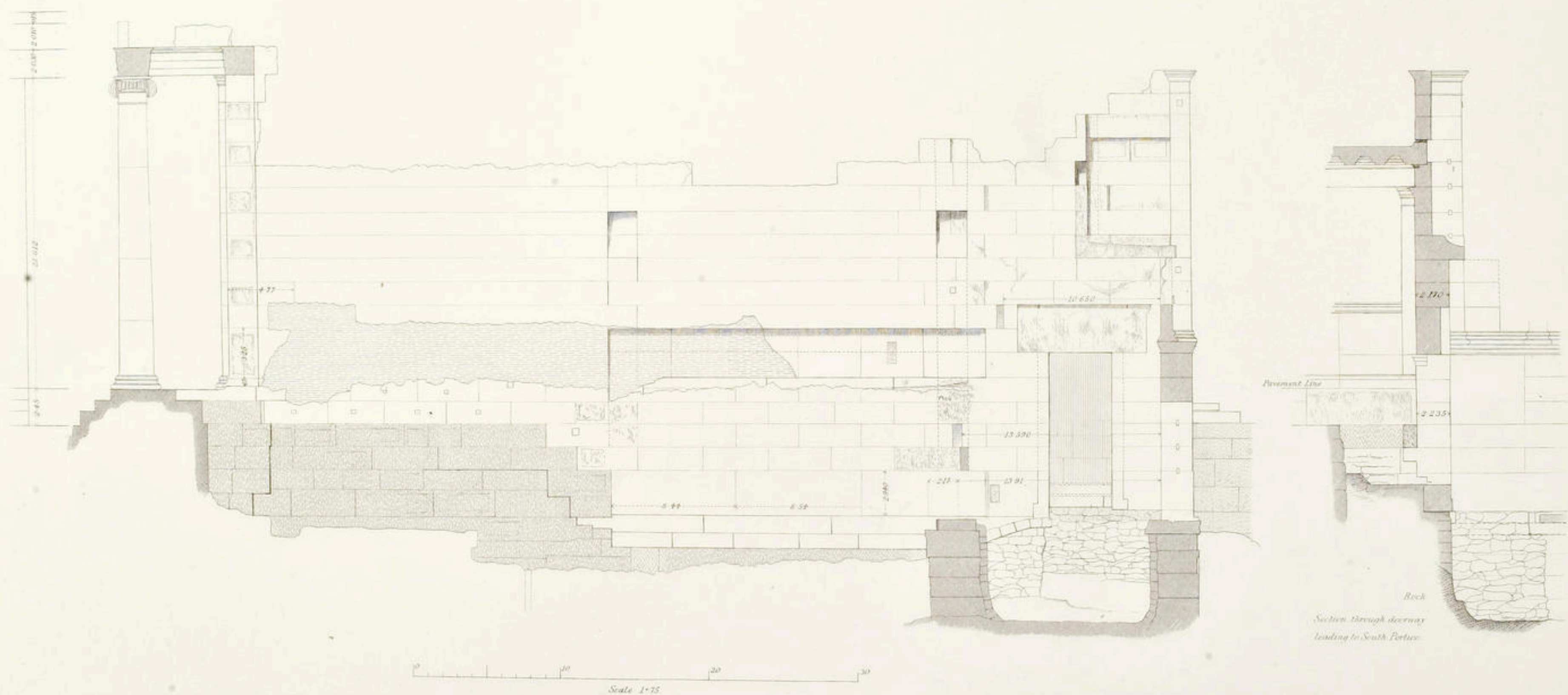


10 0 10 20 30 40 50 ft
Scale 1/75

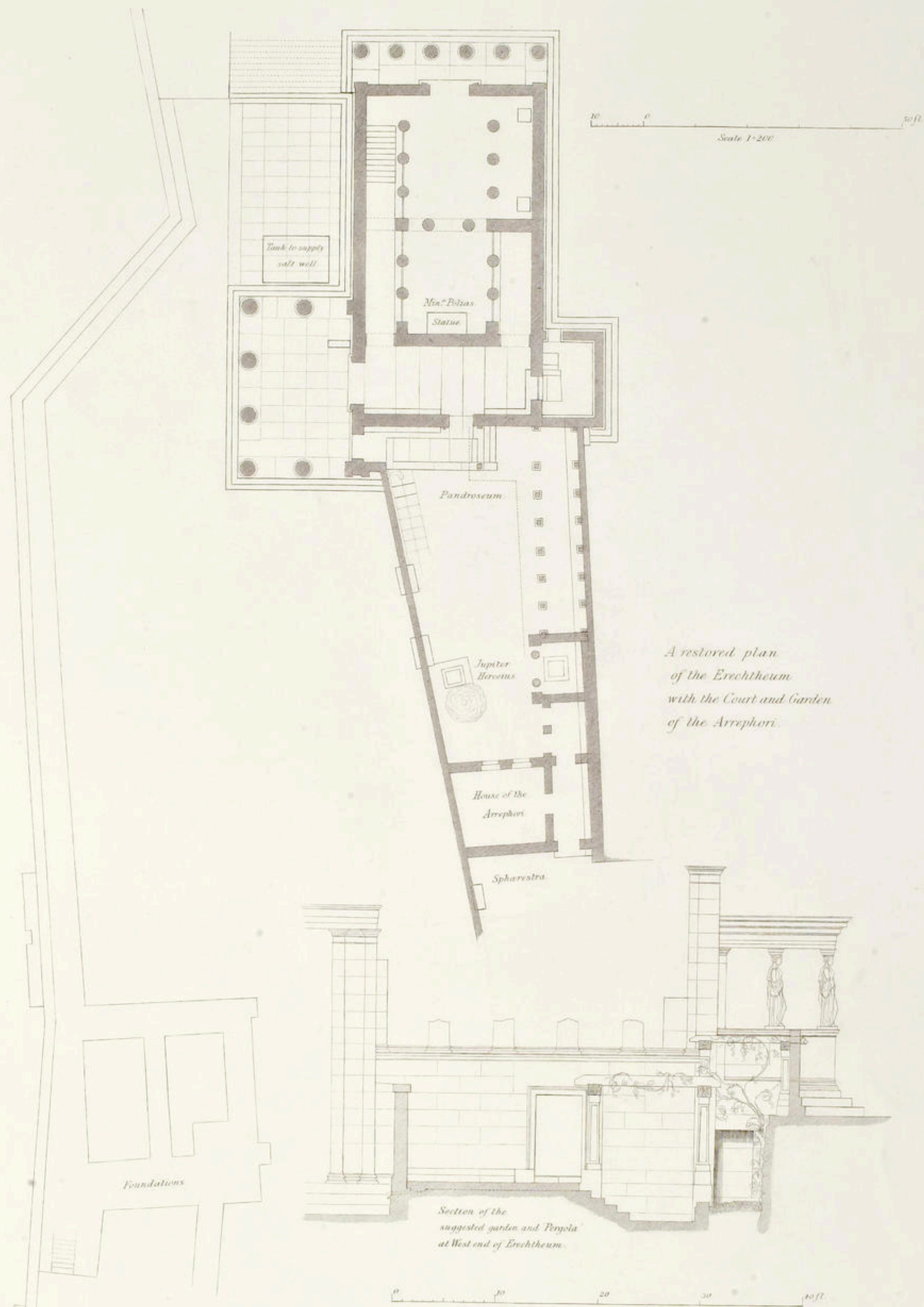
Section of the Erechtheum, looking N.

F.C. Penrose del.

Geo. Searman. sc.



Section of the Erechtheum looking South.



*A restored plan
of the Erechtheum
with the Court and Garden
of the Arrephori.*

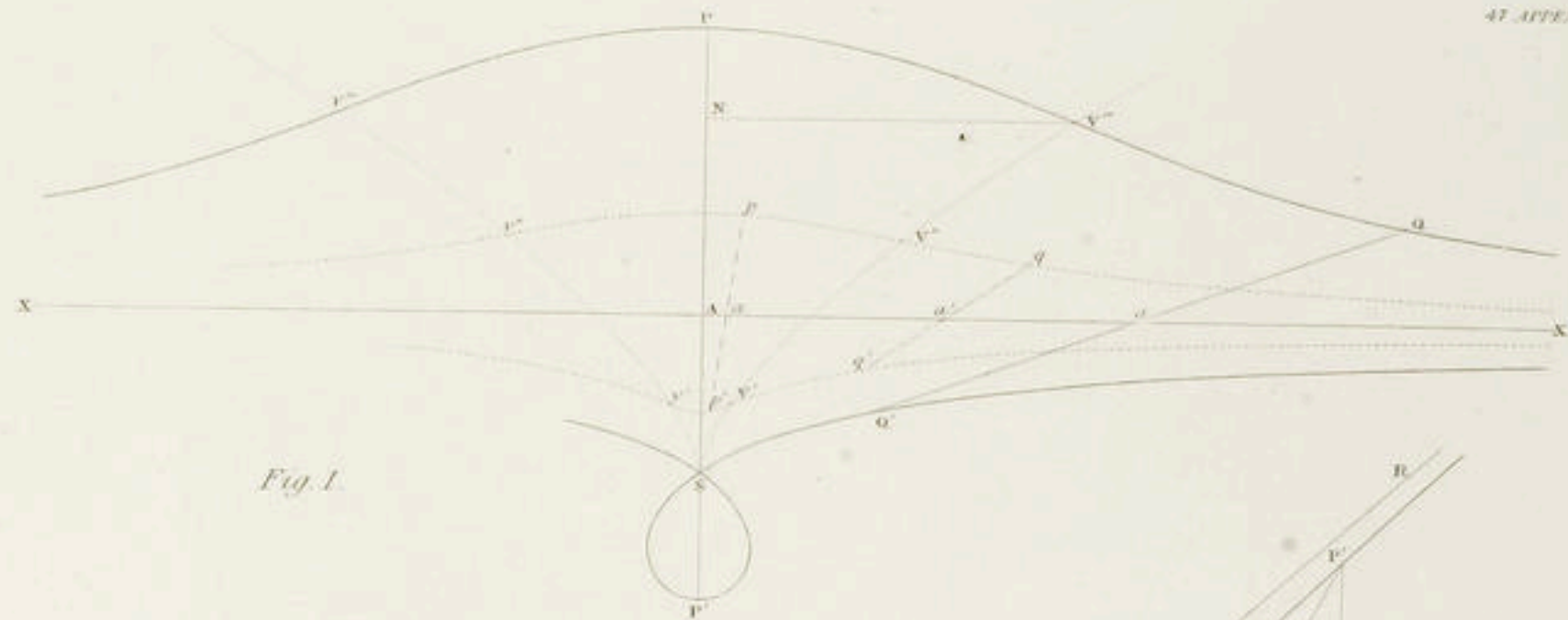


Fig. 1.

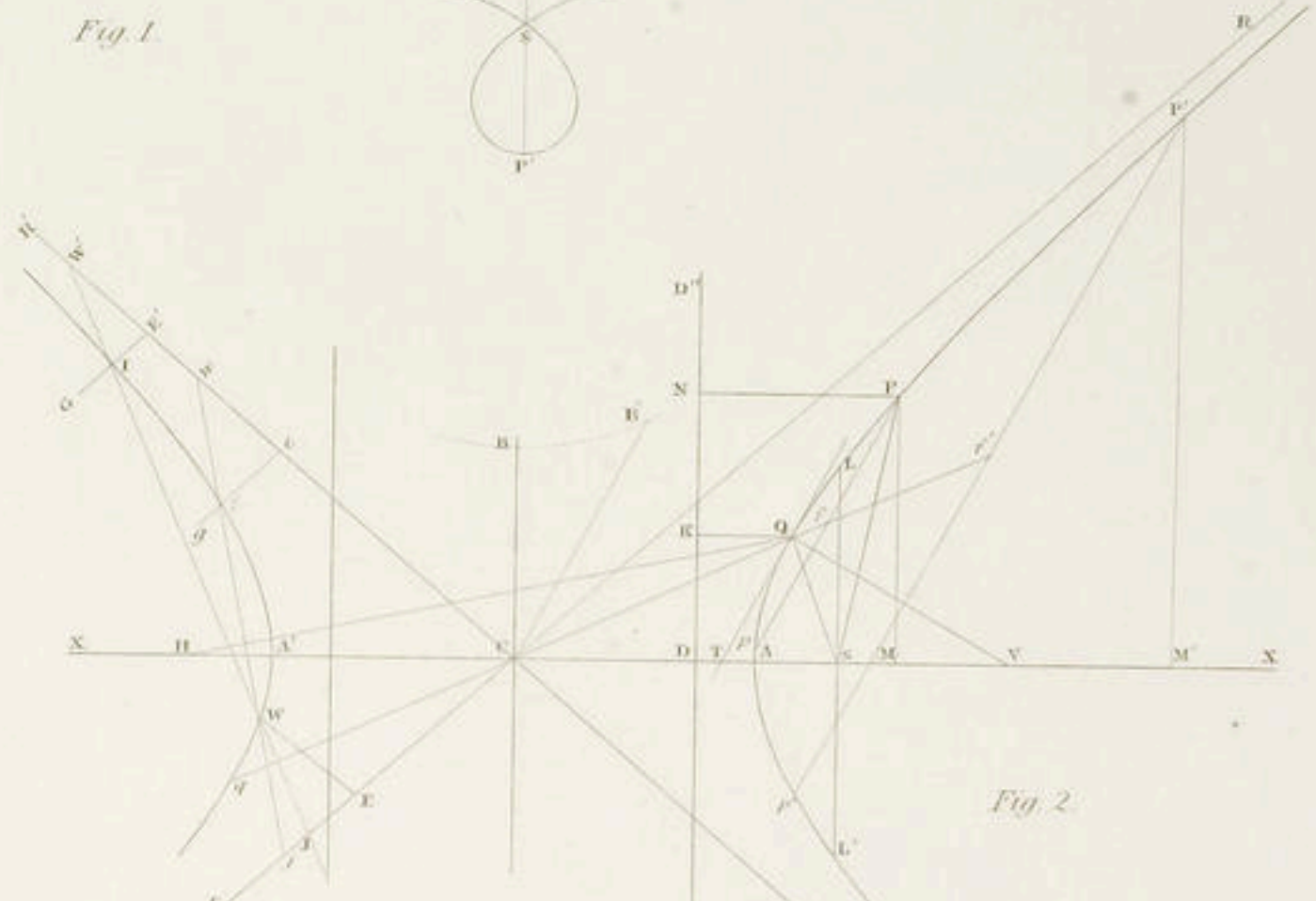


Fig. 2.

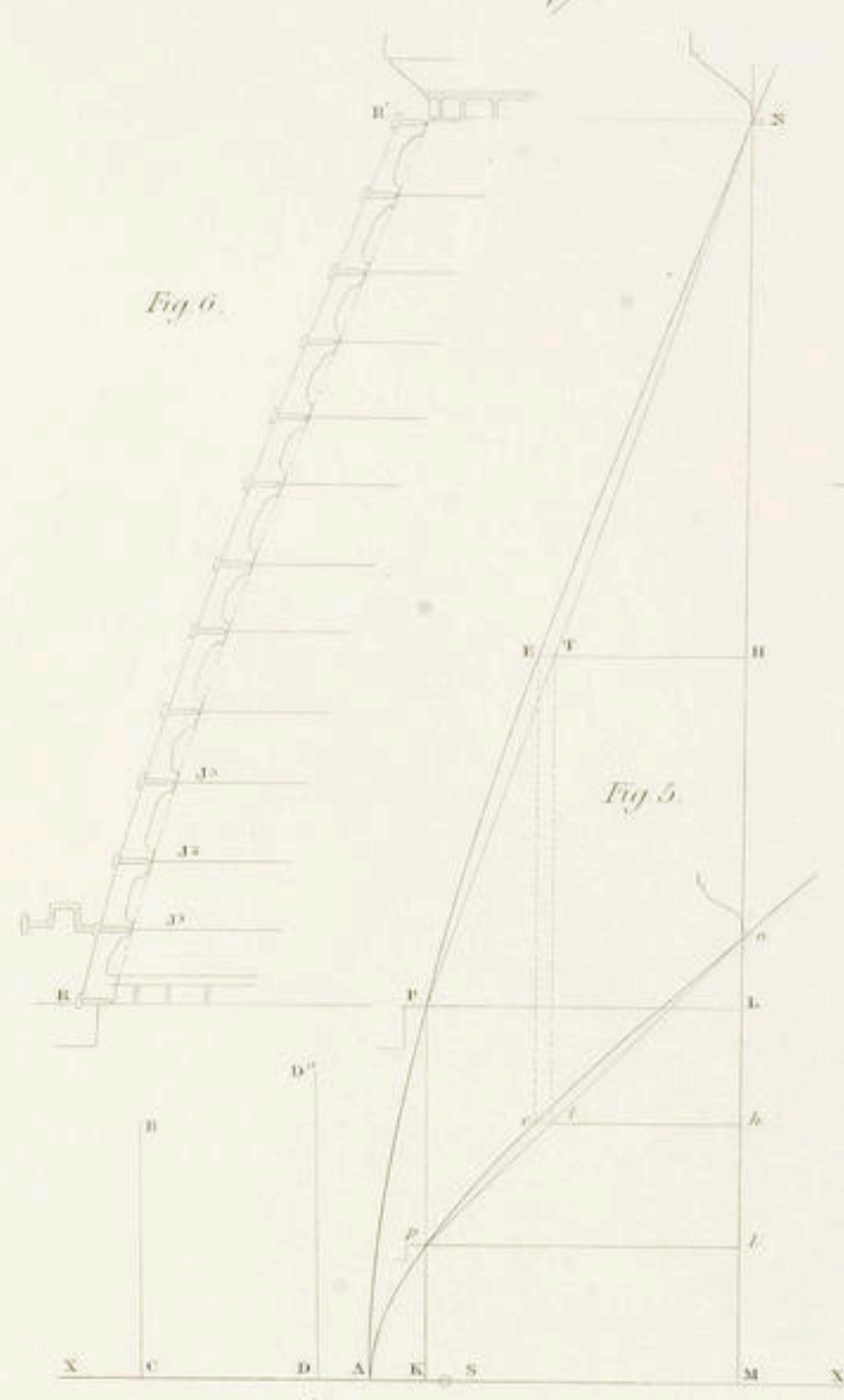


Fig. 5.

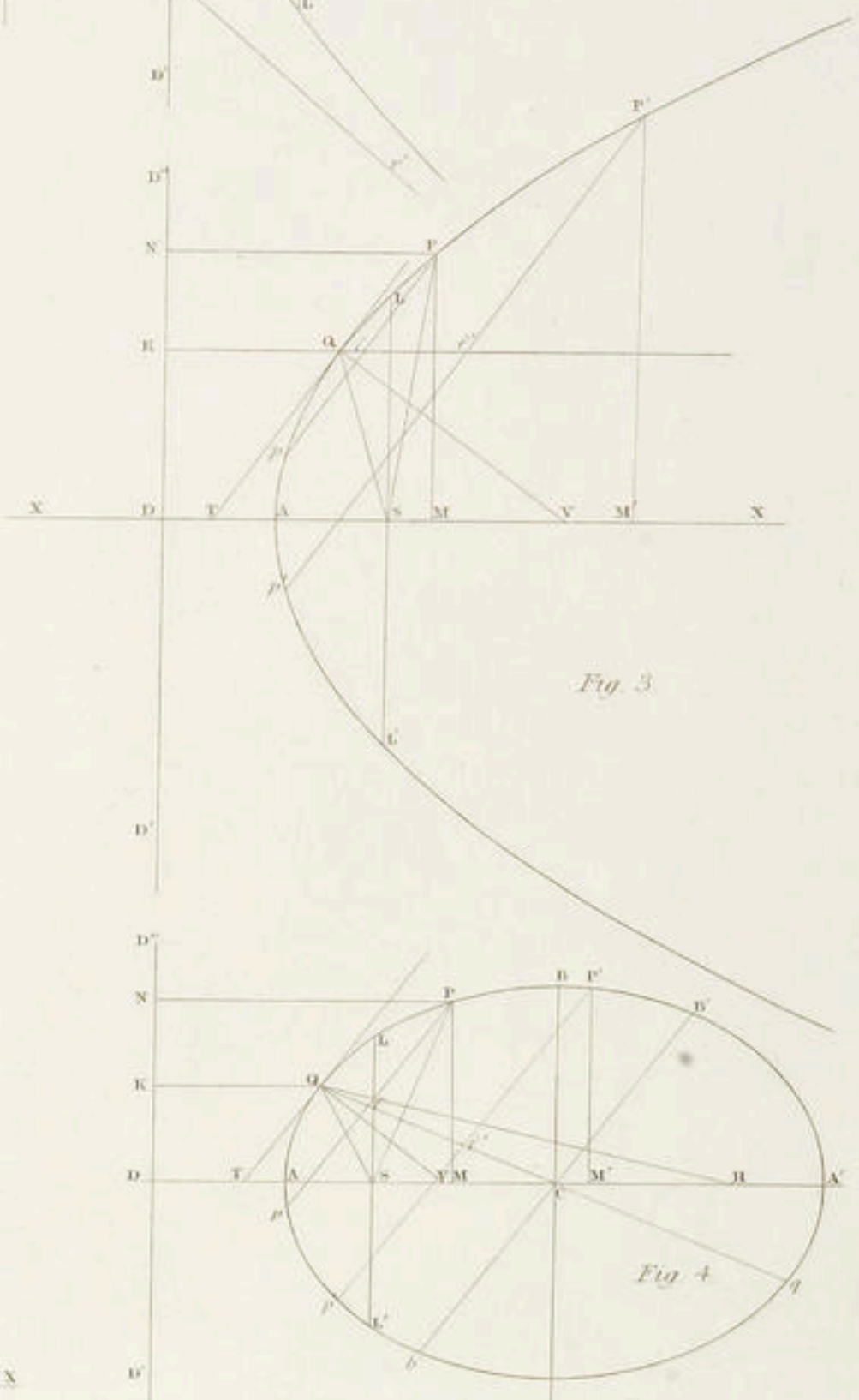


Fig. 3.

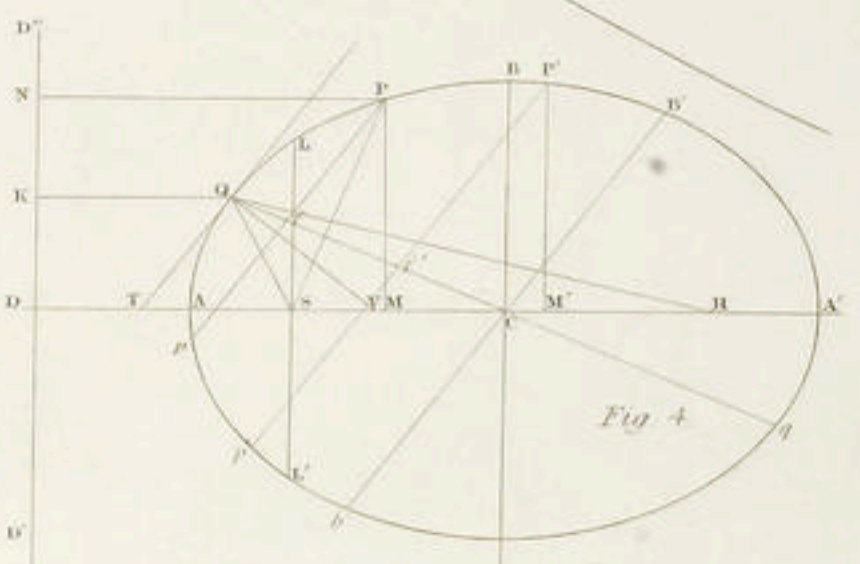


Fig. 4.

T. 2. 2.

T. 2. 2.